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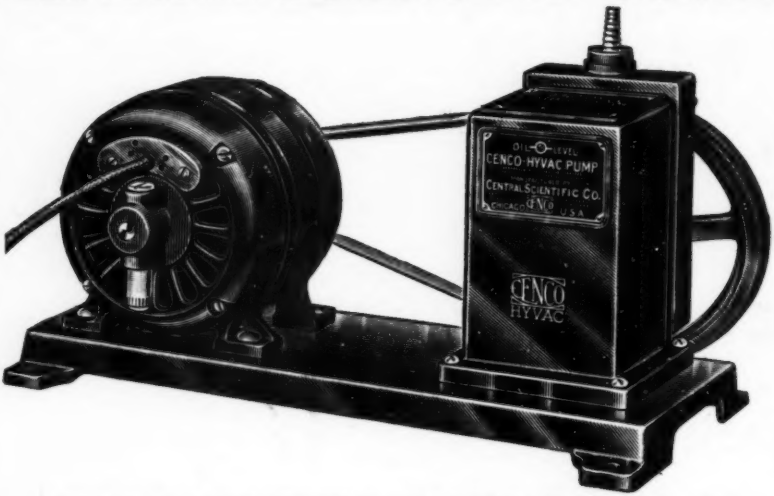

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Vol. V] November 1936 [No. 5

	PAGE
British Association and British Science Guild ..	235
The Discovery of Hafnium. By G. Hevesy ..	236
Hermaphroditism in Dasychone cingulata, *Grube.* By R. Gopala Aiyar and M. K. Subramaniam	240
Letters to the Editor	243
Astronomical Notes. T.P.B.	246
Centenaries. S. Ranganathan, M.A., L.T., F.L.S.—	
Fordyce, George (1736-1802)	247
McAdam, John Laoudon (1756-1836) ..	247
Hutton, Frederick Wollaston (1836-1905) ..	248
Twentieth Century Psychiatry. M. V. Govindaswamy	249
Senescence and Death in Invertebrate Animals H. Srinivasa Rao	252
Reviews	256
Industrial Outlook: Problems of the Leather Industry in India. By Rai Bahadur B. M. Das, M.A. (Cal.), M.Sc. (Leeds) ..	259
International Chemical Engineering Congress of the World Power Conference	264
British Chemical Plant Exhibition	266
Research Notes	266
Science Notes	268
Erratum	268
Supplement to "Current Science"—British Association for the Advancement of Science, Blackpool, 1936	269

British Association and British Science Guild.

VARIED reflections arise from a recent announcement that the British Science Guild will be absorbed by the British Association for the Advancement of Science. At its foundation in 1831, Sir David Brewster stated that the principal purposes of the Association would be "to make the cultivators of science acquainted with each other, to stimulate one another to new exertions, to bring the objects of science more before the public eye, and to take measures for advancing its interests and accelerating its progress."

These words, written more than a century ago, remain to-day the specification of activities ranged by the Association. Probably the most useful of them is " to bring the objects of science more before the public eye," and the September meeting in Blackpool accomplished this purpose very conspicuously. From readers of *The Times*, regaled with a pontific leader on the presidential address by Sir Josiah Stamp supported by columns of extracts from the sectional addresses, down to the Blackpool chambermaid whose principal reaction to the learned and unusual visitors lay in perceiving an increased number of "beards and boots," few Britons can have escaped its impact. There was a time, however, when the Association, as judged by some of its leading members, made insufficient contact with the public; and attention to this imperfection was drawn by Sir Norman Lockyer in his presidential address at Southport (1903) entitled "Influence of Brain Power on History."

Thus came into being the British Science Guild, whose declared object was "to promote the application of scientific method and results to social problems and public affairs." By means of annual addresses named after the founder Sir Norman Lockyer, and Sir Alexander Pedler, coupled with allied activities, the Guild has fully achieved its object within the limits of its resources. Latterly, however, particularly from 1931 when the presidential chair was illustriously occupied by General the Rt. Hon. J. C. Smuts, the British Association itself has given increasing

prominence to social science; and this year's programme included in a separate division the titles of numerous addresses, discussions and papers bearing on the relation between science and the community. In future too, at least one discussion and one evening discourse will cover the application of science to social problems.

Doubtless the British Science Guild, by helpful symbiosis, has been in part responsible for this regeneration of the older body. More potent, however, has been a queer superstition among ascientific publicists that our present mundane woes are somehow owing to the phenomenal advance of science and that men of science being the cause of our troubles, it is their business to adjust them. Twisted as this hypothesis may appear to many, it should not preclude men of science, presumed to be no worse and no better than other citizens, from doing their best in alleviating the present sorrows of citizenship; and if science justifies its definition as organised common sense, a happy issue should emerge. Meanwhile, the Guild may be bidden a grateful farewell, with the comforting assurance that its work has been well and truly done, and that its origin will be conserved in the British Science Guild Committee of the British Association Council. Its action in undergoing voluntary absorption is a seemly example of the now fashionable rationalisation process.

The Discovery of Hafnium.

By G. Hevesy.

(Institute of Theoretical Physics, University of Copenhagen.)

INTRODUCTION.

THE discovery of about four-fifths of the chemical elements without any guidance from the theoretical side and without the aid of the powerful tool provided by spectroscopy, is an outstanding and everlasting monument of the skill, industry, and genius of the experimental chemist. It is with great admiration and deep reverence that we read the papers of the pioneers who succeeded with the primitive tools and methods of their time in discovering and isolating the large majority of the elements. The work of the discoverers of the elements was immensely facilitated later by the introduction of the spectrograph into chemical analysis and by the generalisation put forward by Mendejeleff. It was the guidance offered by the latter which led to the discovery of scandium, gallium, germanium, and recently of rhenium. The periodic classification, so far-reaching in its basic conception and in its applications, failed nevertheless to explain the existence and to limit the realm of the groups of triads and of the large family of rare earth elements. From Moseley's work we could conclude that no more triads are to be expected and that the rare earth group (incl. lanthanum) is limited to a maximum of 16 elements. But the significance of the groups of triads and of the rare earth group was still unexplained and the exact size of the latter still unknown. An explanation was hardly to be expected without a deeper insight into the nature of the periodic classification. Niels Bohr gained such an insight in the course of his classical studies on the building up of the atoms of the chemical elements from nuclei and electrons.

One of the most important points in Bohr's electronic arrangement is that on passing from one element to the next one the number of electrons increases by one, the new electron usually being added to an outermost electronic shell. As the chemical behaviour of the atom depends chiefly on the outermost shell, neighbouring elements in the periodic table will, in most cases, be chemically very different; but in some cases the electronic arrangements might differ in such a way as to give successive elements similar properties. The newly added electron tries to find as stable a configuration as possible and it may happen that an innershell successfully competes with the outermost one in capturing the electron. Such an event is first encountered in the case of scandium, but the most conspicuous one is that of cerium. In the latter case the preference for the new electron is not given to the outermost *P* shell, nor even to the next one *O*, but is given to the inner shell *N*. After cerium come a number of elements all characterised by the binding of the newly coming electron in the deep *N* shell and it is clear that in this group of elements, all having the same configuration in their outermost shell and differing only in an

inner one, the individual members will not differ very distinctly in chemical properties.

In the light of these considerations the existence of the so-called "rare earth" group is no longer an unexplained anomaly of the periodic system but a natural consequence of its development. As the *N* group has 32 electrons and 18 were already present in xenon and the preceding elements, the number of rare earth elements cannot exceed 14 including cerium. Cerium being of atomic number 58, the last rare earth element must have an atomic number 71; element 72 must belong to the titanium and 73 to the vanadium group. In conflict with this conclusion, the literature records the existence of 15 rare earth elements, including cerium and the missing element 61. These 15 elements include also number 72 which, however, according to Bohr's theory, should belong to the titanium group. Besides giving a deep insight into the nature of the periodic classification of the element Bohr's considerations thus supplied an effective guidance in searching for element 72 in the same sort of way that Mendejeleff's generalisation guided the discoverer of scandium, gallium, germanium, and rhenium. I have been asked by the Editor of *Current Science* to describe the discovery of hafnium and it is with great pleasure that I write the contribution requested by this high-standing periodical.

DISCOVERY OF HAFNIUM.

Bohr's theory of the arrangement of the electrons in the different chemical elements was the impetus for the search for a missing member of the titanium group in exactly the same way as Mendejeleff's generalisation induced the search for other missing members of the periodic system. It is of interest to note that in Bohr's famous paper, so far-reaching in its interpretation of the phenomena of optical and X-ray spectroscopy, magnetism, and chemistry, the suggestion that, contrary to the claim of Urbain and his followers, element 72 is not a trivalent element of the rare earth group but a tetravalent of the titanium group, has had to content itself with a modest footnote. It is not too much to say that only in a very few cases has the following up of the suggestions given in the footnotes of scientific publications led to such striking results as in the present instance. But the impetus given, however important, was far from being sufficient and the discovery of the element 72 was due to the happy coincidence of several different events. Six months after the publication of Bohr's famous paper the present writer embarked on the study of geochemical papers including the first publication of Goldschmidt on the distribution of the chemical elements, a paper which was later followed by a long series of most illuminating and unrivalled papers by the famous Norwegian scientist. The study of geochemistry led my interest to the problem of missing elements including element 72. It seemed, however, very doubtful whether the concentration of the element in question would be sufficient to detect it; nor was it clear at the time whether element 72 should be looked for in thorium or in zirconium minerals. I decided to search for the element when a suitable opportunity presented itself. It happened that Coster, who was even then an authority on X-ray spectroscopy, joined the Bohr institute. We made plans for a joint investigation of the effect of very intense and hard X-ray radiation on the rate of radioactive disintegration of radio-lead, by measuring the β-activity of a radio-lead plate before and after irridation with X-rays. While we were waiting for the necessary equipment, I suggested to Dr. Coster that we might look for element 72. We did not know at the time whether this element would be found associated with thorium or with zirconium but considered the latter the more probable. Professor Böggild, Director of the Mineralogical Museum of Copenhagen, kindly supplied me with samples of Norwegian and of Greenland Zircon, and after treating them with boiling acids to remove the soluble constituents, the pulverised sample was fixed on to a copper anticathode. The first exposure taken by Dr. Coster, revealed at once the presence of the element looked for. We then tried to identify the hafnium α_1 line in other zirconium-minerals and also in commercial zirconium preparations, and were successful in every case. The next step was to try to identify other X-ray lines, α_2, β, γ, and so on, and finally to endeavour to change the intensity of the α_1 line by chemical treatment of the mineral. I was much impressed in those days by Marignac's beautiful researches on zirconium double fluorides and this led us to extract potassium-zirconium-fluorides from zircon and to crystallise that compound repeatedly. As the solubility of K_2ZrF_6 is fairly pronounced, while that of the thorium salt is

very slight, we expected the corresponding compound of element 72 to concentrate in the crystals. The hafnium line obtained from the crystals was, however, much weaker than the line given by the original minerals whereas the mother liquor showed a very marked increase in its hafnium content. It was after we had successfully separated hafnium from zirconium by chemical means that Coster and the present writer announced the discovery of the new element, proposing for it the Latin name of Copenhagen, *Hafnium*.

Our next aim was to elucidate the optical spectrum of the new element. We hoped to obtain both the arc and the spark spectrum from the mother liquor of a double fluoride crystallisation of the mineral in which hafnium was first found. Hansen and Werner, who photographed the spectrum found, however, only a very intense niobium spectrum free of tantalum lines. This result, which discouraged them at first, was due to the fact that the double fluoride of the oxyniobate is a very soluble compound, much more soluble than the soluble fluoride of tantalum, zirconium, or even hafnium, so that niobium concentrated in the most soluble fraction. The present writer did not share that discouragement but thought the next best fraction must contain a hafnium concentrate, and this was found to be actually the case. The elaborate work of Meggers identified several thousand lines of the hafnium spectrum, and he showed too that 26 of these lines are to be found among those ascribed by Exner and Haschek to zirconium. On the other hand in the arc spectrum of zirconium measured by Rowland only one hafnium line occurs. By noticing this discrepancy in the zirconium spectrum given by Exner and Haschek and by Rowland it should have been possible to have discovered hafnium many years ago. Accurate atomic weight determinations carried out on zirconium of different origin might also have led to the discovery of the element, but the methods used in early days, which were based on the analysis of the sulphate, selenide, or oxychloride were not trustworthy and yielded mostly values too low, the error being, however, to a large extent compensated by the presence of an appreciable amount of hafnium in the preparations investigated. Venable and Bell, on the other hand, who were the first to use the modern methods of determining the atomic weight of zirconium, namely, the analysis of the tetrachloride, found in spite of very careful work, too high a value, due, as the present writer was able to ascertain, to the presence of 0·7 to 1·0 per cent. hafnium oxide in the zirconium used. While an early discovery of element 72 might have been achieved by comparing the optical spectrum, the atomic weight, or the density of zircon extracted from different minerals, one can hardly imagine that this element could have been discovered by following up the chemical reactions of zirconium compounds of different origin. The chemical similarity between the compounds of zirconium and hafnium is as close as, or closer than, that between any other pair of elements in the Periodic Table. We were very fortunate when we embarked on the separation of hafnium from zirconium to hit straight away on just the two compounds which are most suitable for making the separation desired. These are the phosphates and the potassium (or ammonium) hexafluorides. The hafnium compounds prepared on a semi-commercial scale by the "Auer-Gesellschaft" in Berlin are obtained by crystallisation of the fluorides. Van Arkel, de Boer and their associates in the laboratory of the Philips Lamp Works, in preparing single crystals of hafnium metal by a very ingenious method, obtained a separation by precipitation of the phosphates. The close chemical relationship between the compounds of zirconium and hafnium is also shown by the fact that no chemical reaction is known which would be shown by one of these elements and not the other, and also that zirconium never occurs in minerals without hafnium and *vice versa*. This close similarity was not expected by us when we started our search for missing element 72; although, as was shown a few years later by the present writer, such similarity is to be expected on the basis of the quantum theory of atomic structure.

The chemical character of an element is defined, according to Bohr's views, by the charge on the nucleus of the atom and the attraction exerted by the charge on the electrons of the outermost shell. An increase in the nuclear charge without a change in the arrangement of the electrons has the effect of binding the outer electrons more tightly and the atom becomes less basic. In the vertical groups of the Mendejeleff system such an increase in charge takes place from the lower to the higher elements, but at the same time the valency electrons are displaced

further and further from the nucleus into quantum orbits of higher quantum number. On account of this fact the increased attraction—which is an effect of the increase in the nuclear charge—is actually overcompensated by the greater distance of the outer electrons from the nucleus and the higher members become more basic than the lower. Barium has a nuclear charge 18 units higher than strontium and yet it is the more basic element. In comparing hafnium with zirconium we find a difference in nuclear charge of 32 units, much more than in the case of barium and strontium, while the difference in the quantum number of the orbits is the same in the two cases. In comparing barium and strontium with zirconium and hafnium we have in both cases the same difference in the quantum number of the valency electrons, but in the latter case the much greater difference in nuclear charge, 32 units, can no longer be compensated by the increase in the quantum number of the valency electrons and hafnium is therefore but inappreciably more basic than zirconium. We can always imagine two atoms of very different nuclear charge showing practically the same chemical behaviour provided that the quantum numbers of the valency electrons differ sufficiently to compensate exactly for the difference in nuclear charge.

The next question which occurs is: why has hafnium a nuclear charge so much larger than zirconium? The difference is due to the presence of the 14 rare earth elements before hafnium. That the appearance of the rare earth elements is responsible for the extreme similarity between zirconium and hafnium becomes apparent when we try to draw up a fictitious periodic table containing no rare earth elements and deduce the properties of the element that would follow lanthanum in such a table. After lanthanum there would be a "pseudohafnium," a "pseudo-tantalum," a "pseudotungsten" and so on. These pseudo-elements would all be more reactive than the genuine ones because their valency electrons would be less tightly bound. "Pseudohafnium," would have a density of 9 instead of 13, "pseudo-tantalum" 14 instead of 17, "pseudo-tungsten" 15 instead of 19. Although these pseudo-metals are a mere fiction their compounds are not fictitious. The quadrivalent compounds of "pseudohafnium" are known and in fact are identical with the ceric compounds. This is obvious from a simple inspection of the electronic grouping shown in the following table.

TABLE.

Electronic Arrangement showing the Identity Cerium^{++++} and Pseudohafnium^{++++}.

Hafnium								Hafnium^{++++}							
N				Q			P	N				Q			P
s	p	d	f	s	p	d	s	s	p	d	f	s	p	d	s
2	6	10	14	2	6	2	2	2	6	10	14	2	6	–	–

Pseudohafnium								Pseudohafnium^{++++}							
N				O			P	N				O			P
s	p	d	f	s	p	d	s	s	p	d	f	s	p	d	s
2	6	10	–	2	6	2	2	2	6	10	–	2	6	–	–

Cerium								Cerium^{++++}							
N				O			P	N				O			P
s	p	d	f	s	p	d	s	s	p	d	f	s	p	d	s
2	6	10	1	2	6	1	2	2	6	10	–	2	6	–	–

As is to be expected, the anomalous behaviour of the ionic sizes of the oxides disappears if we replace the hafnium ion by the ceric ion. This observation is not without interest in connection with the earlier, apparently insuperable, difficulty of deciding whether to place cerium in the third or in the fourth group of the Periodic Table. The cerium atom and the cerous ion are not directly related to zirconium, but the ceric ion is the pseudo-homologue of the zirconium ion. Similarly the quinquevalent praseodymium ion would be the pseudo-homologue of the niobium ion.

The investigation of a very large number of zirconium minerals and also of rock samples led to the result that hafnium always accompanies zirconium in nature. Zirconium is chiefly found as zircon and in most cases the hafnium oxide content of zircon is 1·5 to 2·5 gm. hafnium oxide in 100 gm. $ZrO_2 + HfO_2$. From the above

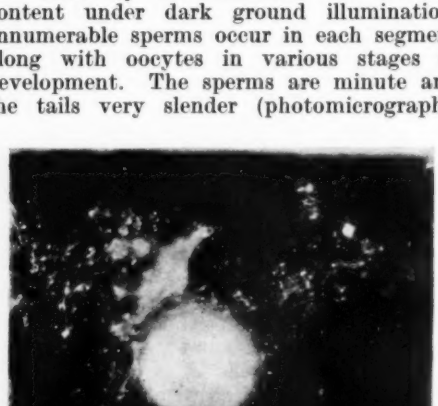
figures and also from analysis of the hafnium-zirconium ratio in meteoric stones, it follows that in the fluid-gaseous stage of our solar system a zirconium-hafnium ratio of about 60 : 1 prevailed throughout and, on account of their similarity, the same ratio is found in present lithosphere. About 1/200,000 part of the earth crust is built up of hafnium, the terrestrial abundance of the latter being as large as that of arsenic, molybdenum or tin.

Hermaphroditism in *Dasychone cingulata*, Grube.

By R. Gopala Aiyar and M. K. Subramaniam.

(From the University Zoological Research Laboratory, Madras.)

DASYCHONE CINGULATA occurs in large numbers attached to the buoys in the Madras Harbour in the 'tank' in front of the Yacht Club. While studying its oogenesis[1] and its anatomy[2] male worms were not seen in the collections. This led to a doubt that it may be hermaphrodite and the occurrence of groups of small cells resembling spermatocytes only confirmed our suspicions. In Champy fixed material, careful differentiation and counterstaining often showed some tail-like structures but in all such cases the head was devoid of any detail. Examination of fresh material under very high magnification revealed occasionally what appeared to be sperms. To verify the discovery we examined the cœlomic content under dark ground illumination. Innumerable sperms occur in each segment along with oocytes in various stages of development. The sperms are minute and the tails very slender (photomicrograph).



After examination of the contents under dark ground illumination a change to ordinary light by a change of condenser reveals only a few sperms and that after very careful scrutiny.

In fixed preparations, except in the first four and the last few, all the segments contain both developing oocytes and spermatocytes, which float freely in the cœlomic fluid. The animal appears to breed throughout the year and no special abundance of either of the sexual products was observed in any particular season.

Since the publication of the list of hermaphrodite polychætes by Johnson[3] only a few forms seem to have been added. We are giving below a list of the known hermaphrodite Polychætes which have come to our notice in the literature available to us.

Hermaphroditism occurs in Polychæta without any discoverable cause and is not confined to any one family or any one group of related families. *Branchiomaldane vincenti* and *Lycastis quadraticeps* are considerably smaller than their immediate allies; but their ova are much larger than those of their diœcious relatives. This increase in size of their ova is not followed by any complexity of organisation or any real advance towards higher plane of being. In fact both *Branchiomaldane* and *Lycastis quadraticeps* are of comparatively simple organisation. Ashworth[4] remarks in the case of *Branchiomaldane vincenti* "In particular, the occurrence of hermaphroditism affords strong evidence of departure from the primitive condition; for hermaphroditism is secondary in Polychæta as it is in Mollusca. This seems clear for, at least, two reasons: (1) because of the few cases of hermaphroditism—only about a score of species—known in Polychæta and (2) because hermaphroditism is generally associated in members of this order, with some obviously secondary modification of structure or mode of life. About half the known hermaphrodite Polychæta are tube-dwelling Sabelliformia while most of the others are Polychætes of unusually small size and simplified structure,—*e.g.*, *Lycastis quadraticeps*, *Ophryotrocha puerilis*. In *Branchiomaldane* hermaphroditism is associated with sedentary habits (as in the case of hermaphrodite Serpulids *Spirorbis* and

List of Hermaphrodite Polychætes.

Name of Species	Family	Finder	Remarks	Reference
Nereis diversicolor	Nereidæ	..	..	..
Platynereis dumerili	..	Caullery et Mesnil.	Incipient. Occasionally Hermaphrodite.	*Ann. d. l'Univ. d. Lyon.*, 1898, **39**, 200.
Lycastis quadraticeps	..	Johnson, H. P.	Giant eggs. Male and female in middle segments.	*Biol. Bull.*, 1908, **14**, 371.
Lycastis indica	..	Aiyar, R. G.	Male and female cells in all segments except in front and behind.	*Curr. Sci.*, 1935, **3**, 367.
? *Lycastis hawaiiensis*	..	Horst, R.	Only egg bearing individuals have been recorded.	*Extrait du department de l'Agriculture aux 'Indes Niederlandaises'*, 1909, **25**, 1.
Lycastopsis catarractarum	..	Feuerborn, H. J.	..	*Verhandl. d. Int. Vereinigung Fur Theor u. Angew. Limnologie*, 1932, **5**.
Macellicephala violacea	Aphroditidæ	Wiren, A.	Hermaphroditism incipient. Males and females occur.	*Zoolog. Studier. Upsala.*, 1902, 289.
Syllis corruscans	Syllidæ	Haswell, W. A.	Anterior somites with eggs and posterior with sperms. Male and female buds occur.	*Proc. Linn. Soc., N.S.W.*, 1885, **10**, 733.
Pionosyllis Neapolitana	..	Goodrich, E. S.	Three anterior segments male and several posterior segments female.	*Quart. Journ. Micros. Sci.*, 1930, **73**, 652.
Grubea protandrica	..	Du Plessis.	..	*Rev. Suisse. Zool.*, 1908, **16**.
Grubea pusilloides	..	Haswell, W. A.	Two anterior male segments and several posterior female segments.	*Jour. Linn. Soc.*, 1918, **34**.
Ophryotrocha puerilis	Lumbriconereidæ	Korschelt, E.	Protandric with hermaphrodite organs.	*Zeit. f. wiss. Zool.*, 1894, **57**, 224.
Sabella microphthalmia	Sabellidæ	Gregory, L. H.	Protogynous—paired hermaphrodite organs.	*Biol. Bull.*, 1905, **9**, 285.
Dasychone cingulata	..	Aiyar, R. G., and Subramaniam, M. K.	Male and female cells in all segments except in front and behind.	*Current Science.*
? *Caobangia billeti*	..	Giard, A.	Only egg-bearing worms have been observed.	*C. R. Soc. Biol.*, 1893, V Ser. **9**, 473.
Amphiglena armandi	Eriographidæ	Claparede, E.	..	*Mem. Soc. Phys. Geneva*, 1868–70, **19–20**, 1.
Spirorbis borealis	Spirorbidæ	Schively, M. A.	Female cells in first two abdominal segments. Male in posterior abdominal segments.	*Proc. Acad. Nat. Sci. Philadelphia*, 1897, 153.
Spirorbis lævis	..	Claparede, E.	..	*Mem. Soc. Phys. Geneva*, 1868–70, **19–20**, 1.
Spirorbis pagenstecheri	..	Pagenstecher, H. A.	Female cells in the middle segments and male cells behind.	*Zeit. f. wiss. Zool.*, 1863, **12**, 486.
*Salmacina dysteri Filograna implexa**	Serpulidæ	Huxley, T. H.	Male gonads 3–5 anterior segments. Female 8–20 segments.	*Edin. New Phil. Journ.*, 1855, **1**, 113.
Salmacina ædificatrix	..	Claparede, E.	Ova in anterior abdominal segments. Sperms in posterior ones.	*Mem. Soc. Phys. Geneva*, 1868–70, **19–20**, 1.
Salmacina incrustans	..	..		..
Pileolaria militaris	..	..		..
Hesione sicula	Hesionidæ	Bergman, W.	With paired hermaphrodite organs.	*Zeit. f. wiss. Zool.*, 1902, **73**, 278.
Branchiomaldane vincenti	Arenicolidæ	Ashworth, J. H.	Male and female elements in middle segments. Giant Ova.	*Proc. Roy. Soc. Edin.*, 1912. **32**, 62.

* G. H. Faulkner[9] thinks with M. Intosh that *Salmacina dysteri* and *Filograna implexa* are synonymous.

Salmacina), and with small size and comparatively simple external form, and may be safely regarded, as in other cases mentioned above, as a secondary character." As *Lycastis indica*[5] which is also hermaphrodite is not " of unusually small size and simplified structure". It is doubtful whether such organisation is a prime necessity for the hermaphrodite condition. *Dasychone* is a tube dweller, but we are of opinion that tube-dwelling may form only one of the many predisposing causes. A search through the literature on hermaphrodite Polychætes reveals that little attention has been paid to the habitat of the animals. Haswell records in the case of *Syllis corruscans* that in specimens obtained between tide marks at Port Jackson in the month of August the posterior orange coloured male region contained only imperfectly developed testes while in specimens taken from deeper water " the posterior orange coloured region was found to be considerably longer; in most it had developed on its first segment two pairs of large eyes, and frequently was found altogether detached from the female." Is this difference caused by the difference in the environmental conditions?

Dr. R. Horst[6] mentions that the genus *Lycastis* is characterised by the facility with which they accommodate themselves to water of greatly reduced salinity. " For, of eight species belonging to this genus five are living in brackish or fresh-water whereas one of them has a strictly fresh-water habitat." In the fresh-water forms Horst observed ripe eggs but no spermatozoa. A re-examination of the sperms of *Lycastis* by us reveals that it is very minute being smaller in size than those of *Dasychone*. It is quite possible that Dr. Horst's failure to see spermatozoa may be due to their minute size. In a footnote to Dr. Horst's paper it is mentioned that *Lycastis hawaiiensis* in the Botanical Gardens at Buitenzorg may have been brought over from the sea along with mangrove plants. " If so, then it is no doubt a very remarkable fact that where in the last two years no mangrove plants have been brought from the sea to our gardens, these worms were able, not only to maintain themselves but even to multiply in these to them quite new surroundings."

We believe that environment and sedentary habits have contributed to the evolution of the hermaphrodite condition. Definite details of the habitats of most of the hermaphrodite Polychætes recorded are unfortunately lacking and our suggestion based on the observations of the habitats of *Dasychone* and *Lycastis* can only be tentative. Brackish water inhabitants show peculiar adaptations associated with reproduction and it is quite probable that a brackish water habitat with fluctuating physico-chemical factors may be responsible for hermaphroditism. In this connection it is remarkable that absolutely nothing is known about the reproductive habits of *Lycastis*. Whether in the brackish and fresh-water forms other modifications affecting reproduction have followed hermaphroditism is not known and a knowledge of it would be of absorbing interest. *Lycastis* has been collected only from the brackish waters of Madras while *Dasychone* which occurs in the Madras Harbour has been collected mostly from the still waters of the 'tank' in front of the Yacht Club where the water exhibits wide fluctuations in its physico-chemical factors, especially during the rainy season.

Pflugfelder[7] in a recent paper describes some new land Polychætes belonging to the genera *Nereis*, *Lycastis* and *Lycastopsis* from Sumatra. One characteristic of these so-called land Polychætes is the enormous development of the mucous glands as seen also in *Lycastis indica*. *Lycastopsis amboinensis* is terrestrial, but *Lycastopsis catarractarum* (Feuerborn[8]) is hermaphrodite and occurs in fresh-water in Java and Sumatra. As most Oligochæta are brackish water, fresh-water and terrestrial in distribution is it not possible that the hermaphrodite condition originated during adaptation to their new habitats through greatly fluctuating environmental conditions?

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LETTERS TO THE EDITOR.

CONTENTS.

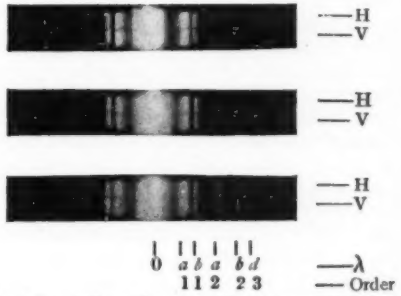
	PAGE		PAGE
Diffraction of Light by Ultrasonic Waves: A Test for Polarisation. By S. PARTHASARATHY	243	*Prospects of Power Alcohol in India.* By A. L. SUNDAR RAO	245
The Synthesis of trans sym.-*Homopinic Acid.* By P. C. GUHA AND K. GANAPATHI ..	244	*Mutual Aid Society for Scientific Workers in India.* By N. G. CHOKKANNA	245

Diffraction of Light by Ultrasonic Waves: A Test for Polarisation.

WHEN a beam of light passes normally through a column of liquid traversed by high frequency sound waves, it spreads into a fan of diffraction spectra. The recent theoretical papers of Raman and Nath[1] indicate clearly that this phenomenon is a transmission effect. It has also been shown by the author[2] that at oblique incidences, the light undergoes characteristic reflections in accordance with a simple formula of the Bragg type. In either case, transmission or reflection, theory does not indicate any appreciable polarisation of the diffraction spectra, provided the angles of diffraction are small.

To test this point, experiments were conducted with a double-image prism interposed between the cell and the photographic plate and so oriented as to give the two images side by side. Tests were made both for normal and oblique incidences of the light beam to the sound wave-front and at frequencies of $7{\cdot}164 \times 10^6$ and $20{\cdot}00 \times 10^5$ c./s.

No polarisation of the lines, either for different wave-lengths of light or for the different orders could be detected. The photograph given above shows this fact clearly.



Polarisation of lines in the diffraction spectra at 20 Mc, taken in *m*-xylene.

(A) at normal incidence; (B) & (C) at inclinations.

(*a*) .. Group of 3 Hg. lines 3650, 4046, 4258 A
(*b*) .. Group of 2 Hg. lines 5161, 5770 A
(*c*) .. Group of 2 Hg. lines 4046 and 4358 A

S. PARTHASARATHY.

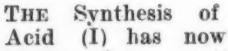
Indian Institute of Science,
Bangalore.
November 11, 1936.

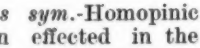
[1] Raman, C. V., and Nagendra Nath, N. S., *Proc. Ind. Acad. Sci.*, 1936, **3**, 459, and earlier papers. A generalised theory is given by Nagendra Nath, N. S., *Ibid.*, 1936, **4**, 222.

[2] Parthasarathy, S., *Ibid.*, 1936, **3**, 594.

The Synthesis of *trans sym.*-Homopinic Acid.

THE Synthesis of *trans sym.*-Homopinic Acid (I) has now been effected in the course of our attempts to synthesise *iso*nopinone (II) and pinocamphone (III).


(I)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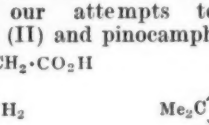
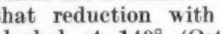

(III)

Ostling[1] reduced *cis*-diethyl norpinate (IV) by means of sodium and absolute alcohol and obtained the glycol (V), b.p. 150–52°/15 mm.; but no details of his experiments and yields are available. It has now been found that reduction with sodium and absolute alcohol at 140° (Ostling's condition) gives the glycol in about 10–20 per cent. yield together with some by-products, whereas by adding sodium all at once to the ester in absolute alcohol (moisture less than 0·01 per cent.) obtained according to the method of Manske[2] the glycol is obtained in about 75 per cent. yield with no by-products. The significant observation is made that both the *cis*- and *trans*-esters furnish the same glycol, b.p. 125–28°/4 mm. (identical with that of Ostling) which has now been proved to be of the *trans*-configuration by oxidation with permanganate to *trans*-norpinic acid. With PBr_3 in dry chloroform solution the glycol gives the corresponding dibromide, b.p. 100–102°/4 mm. with a very characteristic terpene like odour. This on refluxing with alcoholic sodium cyanide for 12 hours gives the corresponding dinitrile, b.p. 142–45°/6 mm., which on hydrolysis with boiling 20 per cent. potash yields *trans sym.*-homopinic acid, m.p. 120–21° (dianilide, m.p. 219–20°). This acid is remarkably stable, distilling unchanged over barium hydroxide. With acetic anhydride under the usual conditions (Blanc) it does not give a ketone but only the double anhydride[3] which with water gives the acid (I). The diethyl ester of (I), b.p. 131–32°/4 mm. gives on prolonged boiling with sodium in xylene solution traces of a product exhibiting properties of a β-ketonic ester. The cyclisation does not proceed in the desired direction to yield the ester (VI) obviously due to the acid (I) possessing the *trans*-configuration. A study of the model also shows that the formation of the bi*cyclo*-(1 : 1 : 3)-heptane ring by the locking of the *trans* valencies in 1 : 3-positions of *cyclo*butane is not possible.[4]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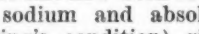
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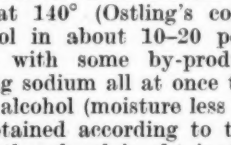
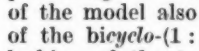

(VI)

In the light of the results obtained in this investigation, Ostling's failure (*loc. cit.*) in getting nopinane (VII) from the dibromide (VIII), can reasonably be explained as due to his glycol (IX) being of the *trans* form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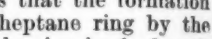
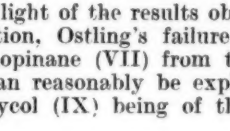

(VIII)


(IX)

the change of configuration occurring during the reduction of pinic ester with sodium and alcohol. Work on the synthesis of *cis-sym.*-homopinic acid is in progress.

This work was done with experimental collaboration of Messrs. D. K. Sankaran and V. K. Subramanian.

P. C. GUHA.
K. GANAPATHI.

Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
October 31, 1936.

Prospects of Power Alcohol in India.

IT will be recalled that as a result of the Sugar Conference held at Coimbatore in November 1933, the Government of India sanctioned the use of 50,000 gallons of alcohol for motor fuel as an experimental measure. The Mysore Sugar Company who conducted the experiment have completed the quota a few months ago; and it is hoped that their experience with the scores of cane lorries running on alcohol has been promising.

In recent months the question of power alcohol from surplus grain has engaged the attention of the United States Government as a means of farm recovery, and, in the very teeth of powerful oil interests, commercial demonstration has been undertaken by the Chemical Foundation who put up a 10,000 gallon distillery at Atchison. In view of this development, despite the cost of their raw material and the magnitude of home production of gasoline, one finds it difficult to understand the lack of initiative in India in the matter of utilising waste molasses for the production of motor fuel.

There have been several proposals for the economic disposal of molasses; but so far the main outlet in the Indian sugar factories has been the waste gutters or sale for export nearly free of cost. It is hardly necessary to point out that none of the methods of disposal suggested could approach in economic value the production of 40 gallons of motor fuel, 300 pounds of carbon dioxide, 75 pounds of fertilising material and 50 pounds of fodder yeast from every 100 gallons of molasses.

Various objections against the use of alcohol in automobile engines have been largely answered or overcome. The author is aware of a series of carefully conducted tests in Mysore with a 6-cylinder car with normal compression running 20 miles per gallon with petrol fuel and 22 with 96 per cent. alcohol. And it is well known that higher compression enhances the efficiency of alcohol, 38–40 per cent. thermal efficiency being feasible at 180–200 lb. per sq. in. as against the 26–28 per cent. that usually obtains in the motor engine running on petrol.

The much talked of difficulties facing denaturation and excise supervision are hardly real, in so much as the United States Government has developed denaturants that apparently have been found satisfactory. There are administrators who refuse to accept petrol as an effective denaturant but, considering the demands that have been in successful use under every conceivable climatic condition, it may not be an insuperable task to devise denaturants to the entire satisfaction of the excise authorities in India. The decision of the Government of India in a matter that has an obviously vital bearing on the future of the sugar industry will be therefore awaited with keen interest.

A. L. SUNDAR RAO.

Allahabad University,
October 10, 1936.

Mutual Aid Society for Scientific Workers in India.

IN view of the great difficulties encountered by scientific workers in India regarding money for purchase of apparatus, books, etc., I think, that a Society should be started on the lines of the German *Notgemeinschaft der Deutschen Wissenschaft*. This Society was started immediately after the Great War to help German scientific workers and has become an invaluable and irreplaceable limb of German scientific activity. The funds for it are obtained by general subscription from all workers (roughly a *mark* or two per month), from industrial concerns, the Universities and from the Government. Any apparatus or book purchased is the property of the Society and is accordingly labelled. These are sent from person to person and from place to place according as the need for them arises. There is a general Governing Council of many eminent men who deal with questions regarding the urgency and necessity of each demand. I hope this idea will catch the mind of scientific men in India and induce them to form a mutual aid society.

N. G. CHOKKANNA.

Indian Institute of Science,
Bangalore,
November 9, 1936.

ASTRONOMICAL NOTES.

1. Occultations of Stars by the Moon.—Observations of lunar occulatations provide an accurate method for determining the errors in the tabular places of the Moon. For the last ten years Prof. Brown and Dirk Brouwer have regularly compiled the observations of occultations made at various places and from a discussion of the results have derived the mean difference for each year of the mean longitude of the moon from the value given in the ephemeris. *Astronomical Journal* 1053 contains a paper by the same authors where 1483 occultations observed in 1934 have compiled and discussed. Observations of only disappearances at the dark limb have been used in the discussion. The mean value deduced for $\delta\lambda$ is $+3''.85$, *i.e.*, the amount by which the Moon was ahead of its tabular longitude.

2. Proper Motions of Stars.—A knowledge of proper motions of stars plays an important part in investigations on the structure of the sidereal universe. The Hamburg Observatory has recently issued an exhaustive publication *Bergedorfer Engenbewegungs-Lexikon*, in two volumes, containing all known proper motions of stars down to the ninth magnitude in both the northern and southern hemispheres. The proper motions are taken from various sources and have been derived from meridian observations as well as from measures on photographic plates. Besides the authority for the motion, are given the magnitude of each star and where available the spectral type from the *Henry Draper Catalogue*.

3. Absolute Magnitudes of Stars of Large Proper Motion.—With the accumulation of parallax observations of stars of large proper motion, the absolute magnitudes of a number of such stars have been determined with some accuracy. On the basis of these data van Maanen has studied (*Publications of the Ast. Soc. of the Pacific*, August 1936) the distribution of absolute magnitudes of stars with proper motion larger than $0''.5$ annually. Combining this result with that found for faint stars with annual motion between $0''.1$ and $0''.5$ in the fields of the "selected areas," he concludes that the maximum of the frequency curve of the absolute magnitudes of stars with large proper motion cannot be fainter than $+10.5$ magnitude—corresponding to a luminosity of .0055 of the Sun.

4. A White Dwarf Star.—From spectroscopic observations at Mount Wilson, the star Ross. 627 is found to be a white dwarf. Its position is given by R.A. 11h. 19.1 m. and Decl. 21° 55′ N and it has a proper motion exceeding one second of arc annually. The spectrum is of type A_0 with wide shallow lines; some interesting details are given in *P. A. S. P.*, June 1936. The star is a faint one of 14.1 photographic magnitude and the distance derived from the parallax measures of van Maanen is about 11 parsecs. The corresponding absolute magnitude is $+13.8$ indicating that the star is one of the faintest white dwarfs known.

5. Variable Stars of R Coronae Borealis Type.—There is a class of irregular variables comprising stars which are ordinarily of uniform brightness, but sometimes decrease suddenly in brightness and vary irregularly until they regain the normal maximum. The recovery of brightness takes a considerably longer time than the drop to minimum. In a short note published in *Harvard Bulletin* 903, C. P. Gaposchkin discusses the spectral characteristics of this type of stars. They are generally of spectral class G, K or R and are found to have an abnormally large amount of carbon in their atmospheres. Typical examples of this kind of stars are R. Ooronœ Boronœ Borealis, R Y Sagittarii and S U Tauri.

T. P. B.

CENTENARIES.

S. Ranganathan, M.A., L.T., F.L.S.

Fordyce, George (1736-1802).

G. FORDYCE, the Scottish physician, was born at Aberdeen on 18th November 1736. While his father was one of twenty children, he was the only and posthumous son of his father. He took the M.A. of Aberdeen in his fourteenth year and entered as a medical student in the University of Edinburgh. He graduated M.D. in 1758 and studied for a year at Leyden.

As a Teacher of Medicine.

At that time regular medical schools did not exist. The students had to depend on private tutors. Mr. Fordyce resolved to make his living by giving lectures to medical students. Accordingly, he commenced a course of lectures on chemistry in 1759 and in 1764 added courses on materia medica and the practice of physic. He continued these courses for nearly thirty years. They were extremely popular. Thousands of students attended them. Some of them became distinguished in their later life. Although his lectures were based on his *Elements of Practical Physic*. 2 V, 1768, which went through several editions, they were said to have been remarkable for rather elaborate logical analysis. Several full copies of notes by his pupils are said to exist still in manuscript.

His Contributions.

He was admitted Licentiate of the College of Physicians in 1765 and became Physician of St. Thomas's Hospital in 1770. He held this latter office till his death. He took an important part in the compilation of the *Pharmacopeia Londinensis* which was issued in 1788. In 1793 he promoted the formation of a Society for the Improvement of Medical and Chirurgical Knowledge. He contributed frequently to the *Transactions* of this Society and to the *Philosophical Transactions* of the Royal Society. The reputation of Fordyce as a medical man rests on his two books *Treatise on Digestion* (1791) and *Dissertations on Fever* (1794–1803). Rejecting all mechanical theories, he treated digestion as a physiological process. His observations on the temperature of the human body were numerous and historically important. He devised experiments to show that the body preserves a constant temperature even in heated rooms. His other publications consist of eleven papers and two books.

Conclusion.

He was elected a Fellow of the Royal Society in his fortieth year. His interests went far beyond medicine. Some of his papers refer to metallurgy, mineralogy, pendulum motion and latent heat and pure chemistry. He worked hard throughout his life. He had conceived the idea that men ought to eat only once in the day and he practised it. He died on 25th May 1802.

McAdam, John Laoudon (1756-1836).

J. L. McADAM, the "macadamiser" of roads, was born at Ayr in Scotland on 21st September 1756. His forefathers had been breaking new ground from time to time. They belonged to the clan of McGregors, which, when outlawed by James II, changed its name to MacAdam. John's father founded the first bank in Ayr in 1763. While an infant, McAdam narrowly escaped death in a fire which consumed his father's house. While studying at the parish school of Maybou, he is said to have given signs of his future eminence as a roadmaker by constructing a model section of a road of the parish.

Sojourn to America.

On the death of his father in 1770, he was sent to New York to learn business under his uncle, who was a merchant. While at New York, he accumulated a considerable fortune and returned home in 1784 and settled down in an estate in Ayrshire. For fourteen years, he lived as a country gentleman and magistrate.

His Discovery.

During this period he was also holding the place of a road trustee. He used this capacity to investigate the conditions of the highways. By many years of careful observations and experiments, he discovered the method of making broken-stone roads. The surface of the ground on the track of the intended roads was to be raised slightly

above the adjoining land; suitable drains were to be formed on each side of the track; it was to be covered by a series of thin layers of hard stone broken into angular fragments of a nearly cubical shape, and as nearly as possible of the same size; no piece was to weigh more than six ounces; the layers of broken stone were to be consolidated gradually by passage of traffic over the road and the covering of the road would thus become a firm and solid platform, nearly impervious to water and durable in proportion to the hardness of the stone of which it was made.

PUBLIC APPROVAL.

McAdam first published an account of this method in a communication addressed to a committee of the House of Commons in 1811. He afterwards wrote a treatise on the subject which went through several editions and was translated into many languages. In 1815 McAdam became Surveyor-General of the Bristol Roads. By 1823 the success of the macadamisation of highways was generally recognised. McAdam's efforts largely contributed to produce the network of mail coach communication, which for some years before the railways were introduced, greatly advanced the nation's prosperity. McAdam's process was adopted in all parts of the civilised world.

PUBLIC RECOGNITION.

On learning that between 1798 and 1814, McAdam had, at his own expense travelled over 30,000 miles of roads in order to pursue his investigations, had spent 2,000 days on these tours and had spent nearly £5,000 of his private money, a committee of the House of Commons of 1823 voted for him an indemnity and a gratuity amounting to £10,000. In 1827, McAdam was appointed General Surveyor of Roads. Besides these, he was offered a knighthood, which he declined. But at his request, the knighthood was conferred on one of his sons, Sir James McAdam, who assisted and succeeded him as a road engineer. McAdam's name has been made immortal in literary English by Southey, Bentham and many others.

While returning from a visit to Scotland, he died at Moffat on 26th November 1836.

Hutton, Frederick Wollaston (1836-1905).

CAPTAIN F. W. HUTTON, the British naturalist, who did poineering work in constructing the Natural History of New Zealand, was born at Gate Barton, Lincolnshire on 16th November 1836. His father was the Rector of the village. Educated at Southwall and the Naval Academy, Gosport, he joined the Indian mercantile marine at the age of fourteen. Having been a midshipman for three years, he left the sea and enrolled himself at the King's College, London. But before the age of twenty he received a commission in the army, became Lieutenant in 1857 and Captain in 1862. He saw service in the Crimea in 1855–56 and subsequently in India during the Sepoy Mutiny, where he shared in the capture of Lucknow and in the defeat of the Gwalior mutineers by Lord Clyde, receiving medal for both campaigns. In 1860–61, he passed with distinction through the Staff College, Sandhurst. The lectures on Geology, delivered by Prof. Rupert Jones in that college, disclosed his bent for science which made him retire from the army in his thirtieth year and migrate to New Zealand in search of opportunity for scientific work.

HIS SCIENTIFIC CAREER.

After unsuccessful farming for a few years, he joined the New Zealand Geological Survey in 1871 as an Assistant Geologist. In 1873, he became Provincial Geologist of Otago and Curator of the Museum. In 1877, he became Professor of Natural Science in the Otago University. In 1890, he was appointed Professor of Biology and Geology in the Canterbury College of the University of New Zealand. He relinquished this post in 1893 to take up the position of Curator of the Christchurch Museum, which he held till his death.

HIS CONTRIBUTIONS.

His knowledge of New Zealand was very wide and not less so was the range of his scientific writings, which were more than a hundred in number and which were chiefly geological, in addition to thirteen official catalogues, of fishes, mollusca, crustacea, worms, echimoderms, sea-anamones and insects. Most of his papers appeared in the *Transactions* of the New Zealand Institute. He also contributed to the *Geological Magazine* and some other British periodicals. He was also the author of *A Class Book of Elementary Geology* (1875), of *Darwinism and*

Lamarckism (1899) and *Indix fauna Novæ Zealandæ* (1904), *Lassons of Evolution* (1902) and *Animals of New Zealand* (1904).

HIS HONOURS.

As early as 1861, he was elected a Fellow of the Geological Society and in 1892 his strenuous work on the Natural History of New Zealand got him the Fellowship of the Royal Society. He became President of the Australasian Association for the Advancement of Science, in 1901 and was the first President of the New Zealand Institute. His review (1861) of the *Origin of Species* gained from Charles Darwin an appreciative letter, of which Hutton was justifiably proud. His contributions to the origin of New Zealand fauna and flora made him known throughout the world as a recognised authority on all matters connected with the geographical distribution of animals and plants.

AS A TEACHER.

As a teacher, he was singularly clear and original in his methods of exposition and possessed valuable faculty of arousing enthusiasm in his pupils, several of whom became contributors to various departments of natural science. Being thoroughly sincere, open and straightforward in all his actions, he was a keen and inspiring critic of anything that bordered on pretence and humbug. After forty years' absence in New Zealand, he came to England in 1905 for a short stay. While on his way back to New Zealand, Hutton died at sea on October 27, 1905.

Twentieth Century Psychiatry.*

THIS book is a compilation of three lectures delivered by Dr. William White of Washington, under the auspices of the Salmon Memorial Trust, at the New York Academy of Medicine in 1935. Dr. Thomas W. Salmon in whose memory the Trust is founded, was the Medical Director of the National Committee of Mental Hygiene, and piloted it successfully through many difficult years. A relevant extract from *The American Journal of Psychiatry* (1931, page 725) regarding the Trust reads as follows:—

> "A meeting in memory of Dr. Thomas W. Salmon was held at the New York Academy of Medicine on Saturday evening, January 10, 1931. At this meeting the completion of the fund of a hundred thousand dollars which was raised by friends and admirers of Dr. Salmon was announced. The custody of this fund has been vested in the New York Academy of Medicine, and the lectures will be delivered under its auspices and the lecturer selected annually by the Academy, and a special Advisory Committee. Under the terms governing the Trust, a scientific worker who has made outstanding contribution to Psychiatry, Mental Hygiene, or a related field must be chosen to deliver the lectures."

Dr. White is the third lecturer of the series, the two previous lecturers being Dr. Adolf Meyer of Johns Hopkins, and Dr. McFie Campbell of Harvard. These three are the senior accredited representatives of American Psychiatry. Their scientific contributions have embraced the whole field of psychiatric thought. Their students are to be found in every Clinic or University of any importance. The writer of this article had the good fortune to be a student of one of them.

Dr. Meyer lecturing on 'Psychobiology' stressed a point of view, of which he is the chief exponent. Dr. Campbell lecturing on 'Destiny and Disease in Mental Disorder' confined himself more or less to the reaction type usually termed Schizophrenic; he interpreted the life experiences of such nervous and mental patients, and showed how from such studies, valuable insight could be gained into forces of human nature, the complex texture of personality, and the varied problems of human adaptation. He also warned of the danger of too much emphasis on the experimental method and the neglect of the broader aspects of human individuality.

Dr. White has continued the tradition, but has been more elaborate and comprehensive in choosing for his subject a review in perspective of the whole progress in psychiatric thought during the twentieth century. His three lectures, "Psychiatry as a Medical Speciality," "The Social Significance of Psychiatry," and the concluding one "The General Implications of Psychiatric Thought," deal with a variety

**Twentieth Century Psychiatry.* By Dr. William White. (Chapman & Hall, London.) 1936. Pp. 198. Price 10*sh.* 6*d.*

of subjects, Medical, Psychological, Sociological and Philosophic.

It is neither possible nor profitable in a review like this to discuss the various problems raised in the book. It is perhaps more preferable to discuss how far the author's expectations and hopes in presenting these lectures in a book form can be expected to be realised. Dr. White hopes to help the reader in these lectures "to discover gradually unfolding to his vision not only a concept of psychiatry in its more limited sense as a medical speciality, but in that broader sense which relates to it all the other departments of thought and experience," and thus of necessity "he will also discover that there is at the foundation of this presentation a philosophy in accordance with which its details are developed and differentiated." This philosophy, the author hopes, will be found to be helpful not only in the restricted area of the practice of psychiatry but in the whole field of medicine not to say the still broader field of human relations.

At the outset, it cannot be sufficiently emphasised that medicine has a destiny to fulfil as a science, and its function does not end with measures to combat suffering and pain. Therapeutics is certainly a very important aspect of medicine, but it is not all. Viewed from this broader aspect of medicine as a science, it becomes intelligible why the numerous publications and research papers published in recent years deal not with mere therapeutics but with formulations regarding the nature of disease and abnormality in general. In this connection the work of Sir Thomas Lewis is of considerable interest. It is only when considered from this point of view, the value, meaning and purpose of Dr. White's book become evident. Dr. White in his lectures emphasises changing orientations and concepts in psychiatric thought, and does not concern himself with mere evanescent details.

The concept of the organism as a whole opposed to the body-mind division claims his first attention. The terms bodily activities and mental processes are purely different aspects of the activities of the organism, the so-called mental processes being total reaction patterns, while the bodily activities are part-reaction patterns. The mind-body relationship is a unity, but the persistence of these words, body and mind, however, as Dr. White points out, leads to some confusion, because our ways of thinking are imprisoned by the forms of our language. These two words have long meant different entities, and unless we think of a better way of expressing this unity, even hyphenated expressions like emotion-intellect, heredity-environment and of course body-mind, may only serve to emphasise the difference and not the unity as we desire they should.

The studies on personality by Dr. Adolf Meyer, from what he terms the psycho-biologic angle, Coghill's biological researches on the behaviour patterns of amblyostoma are concrete verifications of the implications of this concept of organism-as-a-whole. It might be quoted as an example that no type of reaction, however highly specific it might have been thought to be, can ever separate itself from its background, the total behaviour pattern. Secondly, events and responses must be explained by their significance, purpose and ideals; meanings and values are far more important than mere descriptions and classifications.

The psycho-analytic movement is perhaps the most significant single factor which brought about this altered orientation in psychiatric thought—from mere description and classification to meanings and values. The achievements of bacteriology and the progress in microscopic anatomy and pathology on the one hand, and static academical discussions on Psychology on the other, had completely obscured the issues in Psychological medicine. The Physicians and Pathologists were busy on one side groping for a bacterium or a demonstrable pathological structural defect in conditions like mania, melancholia, hysteria, dementia, præcox, etc., which however could not be found, while on the other, the academic psychologists were busy with sterile controversies over non-existent faculties and water-tight compartments of a mythical mind and soul. It was in this big, buzzing, booming confusion that the genius of FREUD BLAZED THE TRAIL.

Dr. White rightly considers that most of the heated opposition roused by Freud's publications was due to their contents, which were sexual, and which were revealed by his analyses. This, Freud could not help, because of the essentially pathological nature of the cases he had for his material. But the methodology he introduced was revolutionary. He contended that the aim of psycho-pathology was to explain the symptoms of abnormal states of mind in psychological terms and not merely to

describe and classify them. Rickmann has observed that up to the time of Freud the tendency of psychiatry has been to turn for help to the physical sciences, which resolve themselves to number, measure and scales. In contrast to this psycho-analysis has another method to offer, which does not enumerate, measure, or weigh; it only deals with presentations in the mind and tries to find by its technique how they are arranged, how they interact, and how they take effect in behaviour. A proper combination of the two methods, Rickmann adds, is the inevitable destiny of psychiatry; at present, there seems no way of fusing the two, so that the Clinician is obliged to use the two alternately, viewing now the Psychical, now the chemical, regarding the patient at one moment ontogenetically, at the next moment as the subject of statistical research. Dr. White, although an ardent believer in psycho-analysis, has, however, no illusions about the same. He recognises that it is only one of the approaches to the problems of the mind, and to its therapeutics. And that the impossible claims made for it by some of its advocates, only hinder its usefulness.

Side by side with the psycho-analytic movement, and as some people seem to think as a corollary of or supplementing the same, arose the Mental Hygiene movement, with its offspring, the Child Guidance Clinic. It is a matter of common knowledge that Clifford Beers (author of *A Mind that Found Itself*) the driving power behind the movement was himself a mental patient, and that his sympathy with the sufferers, and the deplorable manner in which the patients were treated, was responsible for the foundation of this movement which is now a huge international organisation. The Mental Hygiene movement is essentially a public health movement which has as its major objective the prevention of the disabilities and wastage of mental disease. That mental disorder can, to some extent at least, be looked upon as preventable, is a startling innovation. Its sociological and educational implications are obvious. Moreover, it gives a new orientation to the inert notion of the inevitableness of heredity. Both heredity and environment are not any more separate and distinct facts unrelated to each other, but they are just like body and mind, only two aspects of an organism which grows out of and into an ever-changing environment. If we accept that everything abnormal is based upon a hereditary background which determines in its very inception and for all time what its consequences shall be, then there is nothing to be done about mental disease at all. But it is only because, we believe that to some extent at least, we could modify human beings, and that we can remove some of their difficulties and disabilities, we are able to understand the extraordinary, sometimes almost miraculous, therapeutic successes.

Closely associated with this problem of heredity, is the consideration of the physical make up of the individual, which is largely, if not fully hereditary in origin, and which has within it certain corresponding types of thinking and feeling. Kretschmer's work on the close association between the thickset individual and affective disorder, and the asthenic individual with morbid introversion and schizophrenia is too well known to need comment. But both Kretschmer's work on physique and Jung's work on extroversion and introversion, however suggestive, should not be taken too literally. Because clear cut, concrete, and definite psychological or biological entities exist nowhere in the universe. A belief in such represents only the extreme of the wishful attitude of man towards reality.

Before leaving this part of the subject, it is wise to remind ourselves that all these problems of growth and development, psychological and physical, are merely functions of time. The new orientation from purely space thinking to time-space thinking is as significant in psychiatry, as the time-space continuum in fourth dimensional physics.

Dr. White deals also with the influence of psychiatry on criminology, delinquency and education, but what he has said is common knowledge and needs no comment. The contribution of psychiatry to medicine can hardly be too often repeated. A patient is not a more or less incidental container of an interesting biochemical, physiological, or bacteriological situation, but is something far more. A clinical picture is not a mere photograph of a man sick in bed. It is an impressionistic painting of a patient surrounded by his home, his work, his relations, his friends, his joys, sorrows, hopes and fears. A doctor is not treating a disease, is not treating a mere case, but a human being, in whom the importance of psychology is over ninety per cent., and of physiological pathology less than ten per cent.

While these paragraphs were being written two reviews of the same book have appeared, a lengthy one in *Mental Hygiene* of July 1936, and a very short note in the *Lancet* of August 22. While that in *Mental Hygiene* is very fulsome in its praise, the note in *Lancet* is very lukewarm; and hardly just to the author. "He has high hopes of what may be done for civilisation by the use of psychological knowledge; of those major threats, which make optimism difficult for Europeans, he scarcely speaks at all." One often feels that the problems of dictatorship, tyranny, aggression, and of mob hysteria agitating Europe have in spite of a common human background aspects which are purely individual to Europe, and a non-European cannot deal with these problems with the same authority as a European can. What constitutes progress is only a point of view, and Dr. White with his experience of forty years has lectured on what he feels he could speak with authority, on subjects which he thinks need comment, and in a field in which he has not been an idle spectator, in contrast to the many compilers of recent advances. One cannot quarrel with Dr. White on this count.

Just as in other books, which are compilations of lectures, in this book also there seems to be a lack of coherence and sequence; a certain amount of repetition and disproportion. One notes also with regret a tendency to soar from facts to 'beyondness,' in a way out of keeping with past form,—a failing noticeable in many other great men, for example Jeans and McDougall, and latterly in Jung.

Every intellectual revolution which has ever stirred humanity to greatness has been a passionate protest against inert ideas. A great idea in the background of dim consciousness is like a phantom ocean beating up on the shores of human life in successive waves of specialisation. Wholes can no more be studied without reference to parts than parts without reference to wholes. *Twentieth Century Psychiatry* is in large part a contribution by man to a knowledge of himself.

M. V. GOVINDASWAMY.

Senescence and Death in Invertebrate Animals.

THE causes of death in mankind due to disease or old age have been the subjects of investigation by man ever since he began to show scientific curiosity in these phenomena. In his attempts to prolong his wonderfully interesting life, man has wandered into the pathless regions of speculation in regard to life, death and the soul of the individual, and stumbled on the sciences of Chemistry, Biology, Medicine and Hygiene. Man's interest in his domestic pets, chiefly of the mammalian and avian species, led him to investigate the problems of old age and death in Vertebrates other than man, and the phenomena of parasitism and of monstrosity in plants and Invertebrate animals of economic value. Not until recent years, however, was systematic attention focussed on the phenomena of senescence and death in various groups of Invertebrate animals. The great volume of literature on this subject, when critically examined, shows that it is essential to distinguish clearly between two types of data, (1) relating to changes in the organisation of Invertebrate animals due to normal physiological conditions, and (2) relating to changes due to pathological conditions.

What are the signs of senescence observed amongst the Invertebrates of the various phyla of the Animal Kingdom, does senescence actually lead to death in these animals, and what are the various views held in regard to the causes and significance of senescence? Illuminating answers to these questions are given by Dr. István Szabó of Budapest in an excellent summary of the literature on the subject in *Rivista di Biologia*, XIX, Fasc. III, 56 pp. (1935) to which is appended a fairly exhaustive list of references.

There are two fundamental views held in regard to the process of ageing. The earlier view held by Weismann and others was that ageing is a wearing out of the tissues, while the more recent one held by Minot, Baer and others is that it is a part of the developmental process of the animal, or as Raymond Pearl holds that senescence is not an indispensable peculiarity of life. Between these two extremes, and explanatory of the one or the other extreme is a variety of views in regard to the causes of senescence and consequent physiological death. One view is that senescence and death are caused by aggregation of living cells as in multicellular

organisms and by organic differentiation, a second view is that they are brought about by the poisoning influence of metabolism, or by the insufficiency of excretory processes or of metabolism, a third view attributes old age and death to the decay of assimilatory activity, a fourth view to the exhausting effect of the reproductive processes, a fifth view holds that death is an essential aspect of life, a sixth holds the struggle for existence between different parts of the organism as responsible for its old age and death, a seventh attributes senescence and death in animals to the colloid character of living substance. According to the last mentioned view, death of the organism is caused by the increasing density of the protoplasm. Szabó thinks that as each individual repeats the ancestral history according to the Biogenetic law, the colloids thicken gradually leading to senescence. One author atributes the thickening of the protoplasm to the law of gravitation, which holds good for all living matter.

Among Protozoa destruction of the nucleus and other parts of the organism seem to represent the changes due to senescence. The occurrence of peculiar modes of reproduction (by fission and reorganisation) in the Protozoa by which the parent organism divides itself into daughter organisms has earned for this group the reputation of being potentially immortal, but the loss of individuality sustained by the parent organism provides an argument for holding the opposite view. In Protozoa death can only be considered as external, that is to say, Protozoa are exempt from physiological death. Nevertheless, senescence in Protozoa is as much potential as immortality. The classical experiments of Child, Prowazek and others with young and old individuals of various kinds of Protozoa show that they suffer old age without resulting in death, and that the continuity of life is maintained indefinitely by a process of rejuvenation.

In regard to Sponges, Bidder, Minot and Arndt consider that there is no senescence, although degeneration and reduction of parts may take place as a result of starvation or of other unfavourable conditions. Szabó thinks that the question of senescence in sponges can only be settled by further careful observations.

In regard to Coelenterates, the works of Hertwig, Boecker, David, Gross, Hartlaugh and Schlottke are reviewed showing the divergence of opinion amongst authors with reference to the causes of senescence and death. Hertwig observed that the same causes which result in the death of *Hydra fusca* in cultures may also lead to the development of reproductive organs, the only difference between the two phenomena being the degree of intensity of depression in cultures, the greater producing death and the lesser sexual reproduction. Boecker and Goetsch found that organisms in cultures recovered from depression, and therefore considered depression as a sign of pathological phenomenon and of cessation of feeding, bud-forming and assimilation. According to Hartlaub, the approach of death is heralded by the cessation of sexual reproduction. David and Gross thought that *Hydra* was potentially immortal. Schlottke found that all except the interstitial cells in *Hydra* were subject to senescence and death, and the latter category of cells gave rise to other cells. He, therefore, thought that *Hydra* was potentially immortal.

In *Rotifera* the signs of senescence were studied by various authors. Noyes observed in *Proales decipiens* that although old animals fed continuously digestion and defecation did not take place. Jennings and Lynch found that in old *Proales sordida* the movements were slow, feeding process inefficient, and the tendency for the head to get attached by some secretion. Plate observed swelling of the middle parts and the tucking in of the extremeties in *Collidina magna* as the signs of senescence. In *Rotifera vulgaris* Speman found that the signs of old age were creeping instead of swimming, slower reactions to external stimuli, shrinkage of the body and crumpling of the integument, loss of elasticity of muscles, and cessation of reproduction. In *Lecane inermis* Szabó, M., observed slower movements, the tendency to remain rooted to one place for long periods and to fall to a side from which position they cannot raise themselves. The animals, however, fed till death, but stopped defecation 24 hours earlier. In all the species of *Rotifera* studied, ciliary movements in the cells of the Oesophagus and the excretory organs continued till death whatever the changes due to senescence.

In the Nemertine worms Sekera observed decrease in body size and heavy pigmentation of the integument as the signs of senescence.

In the Polychæte worm *Hydroides pectinata*, Harms observed signs of senescence to be less irritability, stagnation of blood in abdominal vessels, irregular peristalsis in the gut, and gradual degeneration of the segments of the abdomen from behind forwards. Provided that the animal is able to get rid of its degenerating abdomen from the thorax, the latter can regenerate a new abdomen. The deeper cause of senescence seems to lie, however, in the central nervous system, in particular the parts which control the blood-vessels, where degeneration sets in while the rest of the tissues are histologically normal. Even after the whole brain has almost degenerated and the cell-outlines are obliterated, irritability seems to persist. Harms did not consider the appearance of pigment in worms, as also in Coelenterates and Arthropods, as a sign of senescence. Stolz observed shrinkage of the body, cessation of budding and degeneration of the digestive system in *Aelosoma hemprichii*. In the asexual oligochætes of all ages (*Nais communis* and *N. variabilis*) Stolte found symptoms of old age in slow movements, in reduction of peristaltic activity in the gut and of pulsation in the blood-vessels, in the flattening of muscle epithelium and muscle layers, in the accumulation of metaplastic material (chloragogen bodies), and in the death of the intestinal and nerve cells. He was of opinion that senescence and physiological death were caused by the discontinuance of the production of reserve cells and by degeneration of the mass of nerve fibrils in the visceral ganglia, although the latter were less striking. Szabó concludes from Stolte's studies that physiological death is caused primarily by degeneration of the gut-chloragogen system.

In Crustacea senescence changes have been observed by Walter in *Cyclops viridis* to begin in the nervous system, chiefly brain, as atrophy of cells, leading to the breaking off of setæ, clumsy and unbalanced movements, and cessation of feeding.

Changes similar to those observed in *Cyclops viridis* were described by one author in the case of Phasmidæ, but these have been contradicted by a later observer. Metschnikoff found in moths cessation of excretion and accumulation of excretory products. Other observers like Krumbiegel, Blunck, Janish, Pixell-Goodrich and Schmidt, to name only a few, have studied the changes of senescence in beetles, wasps, bees and other insects. In these, deposition of metaplastic substances and pigments, general signs of atrophy or hyperplasia or both were the changes observed.

In regard to Mollusca the investigations on senescence changes are more varied. Burnett Smith observed in Gastropods the following changes amongst others: passing of the shoulder tubercles and spines into a shoulder keel, protrusion of the mantle in the region of the anal siphon, stromboid form of the outer lip of the aperture, tendency towards looseness of the coils, irregularity of growth lines, thickening of the shell, tendency to the formation of smooth and rounded whorls, and discontinuous or recurrent ornamentation. Myonier de Villepoix found that in *Helix aspersa* the gland cells of the mantle disappear, and the cells of the mantle epithelium only are capable of dividing. Szabó, I. and M., studied the changes due to senescence in various forms of Mollusca (*Helix*, *Arion*, *Agriolimax*, *Coretus*, *Planorbis*, *Limnæa* and *Viviperus*) from the points of view of morphology and histology and came to the conclusion that the cause of senile death lies in the liver as in *Agriolimax agrestis* or in the nervous system as in *Limax flavus*, the two species which were investigated in great detail by the authors. One of these two might be primary and the other the secondary cause of death. In the liver it is the increase of connective tissue, and in the nervous system the accumulation of pigment, which causes death.

In addition to the various signs of senescence such as atrophy of cells, accumulation of pigment, increase of connective tissue, loss of weight, etc., Szabó considers the change occurring in the proportion of the nucleus to the cytoplasm as not the least important. But opinion in regard to the nucleo-plasm ratio seems to be divided. One set of observers working on Vertebrates and other Metazoa holds that it is the cytoplasm which increases in proportion to the nucleus during senescence, while another set working on Protozoa holds the opposite view, namely, that the nucleus increases in proportion to the cytoplasm. But considerable doubt has been thrown on this point by the work of Günther Hertwig who showed that such changes as occur in the ratio of nucleo- and cytoplasm were due to the effect of fixatives. Szabó, however, is of the opinion that chemical tests as applied by various investigators (Masing, Schæffer,

Robertson and others) indicate the occurrence of a change in the nucleo-plasm ratio as one of the signs of senescence.

The changes produced by senescence are not uniform in the various species of animals. In one species the signs of senescence are observed in the nervous system, in another in the alimentary system, in a third in the genital system or other organs. In some species all organs show signs of senescence simultaneously as in ants, while in others the genital organs are primarily affected. For every species, therefore, there seems to be a characteristic mode of senescence. Even among individuals of the same species senescent changes may differ as shown by Szabó in *Agriolimax*, by Jennings and Lynch in *Proales*, by Stolz in *Aelosoma* and by Gross in *Hydra*.

Concluding this systematic survey of facts known in regard to the modes of senescence in various groups of animals, Szabó discusses certain general aspects of the subjects of senescence, rejuvenation and potential immortality.

With regard to the influence of germ cells on senescence Szabó is of the opinion that atrophy of these cells cannot be a primary cause of death. Reproductive activity may perhaps weaken an organism, and the state of the germ cells in this weak condition may influence the speed of senescence. In *Agriolimax agrestis*, Szabó, I. and M., observed the scarcity of undifferentiated germ cells (which the authors have designated as the Polimanti cells) in young and egg-laying individuals, and the aggregation of these cells to form a definite tissue (the Polimanti tissue) in non-egg-laying animals with a long span of life. Where this tissue was well developed, genuine atrophy in other cells of the body did not occur. So the conclusion was drawn that the presence of Polimanti cells in some way increases the span of life by maintaining the metabolic rate unchanged and thus delaying atrophy.

Szabó then discusses the results of Child's experiments on senescence and rejuvenation. Child studied the reactions of various animals of all ages such as *Planaria*, Coelenterates, Crustacea and larval amphibians in various media, such as cyanides, ethylalcohol, chloroform, etc., under constant temperature conditions, both in high and low concentrations, and observed how long animals of different ages lived in media of high concentration or acclimatised themselves to media of low concentration. Because of the varying rates of metabolism in animals of different ages, the younger animals were observed to die sooner in concentrated media than the adults, while in media of low concentration they lived longer than the adults. Whether the mode of reproduction is sexual or asexual, the degree of susceptibility depends only on differences in age. Child also observed that in Invertebrates with highly developed power of regeneration, the process of senescence often led to rejuvenation, whether the mode of reproduction was primarily sexual or asexual. From the point of view of senescence and rejuvenation the sexual and asexual modes of reproduction are, therefore, fundamentally similar processes.

The question of potential immortality is discussed by Szabó in detail. If a cell or an individual is potentially immortal, then it does not grow old, or its senescence is balanced by certain processes by which the cell or individual is rejuvenated. In the Metazoa the continuity of the germ-cells is generally accepted as a sign of potential immortality, and from experiments on the tissue culture of Vertebrates it seems likely that cells of tissues of the body other than those of the reproductive organs have a tendency towards potential immortality. In the Protozoa the individuals have a tendency to grow old, but rejuvenation arrests the progress of senescence and maintains the continuity of life. In the lower Metazoa such as worms, Coelenterates, etc., parts of the body are potentially immortal. Immortality seems, therefore, to be a primitive characteristic of unicellular and multicellular lowly-organised animals. It may mean that the animal as a whole or particular tissues do not grow old or that senescence is compensated for occasionally by rejuvenation. For this reason the author suggests that the physiological experiments on potentially immortal organisms should be verified by careful microscopical examinations of the tissues to detect the minute changes due to senescence.

Reviewing the field of literature, death in organisms apart from pathological causes and accidents seems to be the result of cells living together—a heavy price to pay for corporate existence.

H. SRINIVASA RAO.

REVIEWS.

Collected Scientific Papers of Sir William Bate Hardy, F.R.S. Published under the auspices of the Colloid Committee of the Faraday Society. (Cambridge University Press.) 1936. Pp. xi + 922 with 15 Plates. Price 63*sh*. net.

This is a superb volume. It is a worthy memorial of a great scientist whose labours have elucidated some of the abscure problems of the living substance. The work contains fifty-nine contributions, capable of being arranged under three heads: Physiological and histological problems of the colloid state and the behaviour of liquids and solids at their interfaces. These papers have shed considerable light on the functions of the living cell.

In the preface Professor Eric K. Rideal gives us an insight into the scientific lifework of Hardy and observes as follows:—

> "A number of excellent accounts have been published of the scientific life of Sir William Hardy, but no better epitome has been given us than that expressed by Sir Hugh Anderson, the late master of Hardy's College, Gonville and Caius. 'Hardy once observed a cell divide under a microscope and wondered why.' The wonder excited in Hardy by the observation of cell division set him on the path of these investigations on physico-chemical properties of the proteins and the behaviour of matter in the boundary state."

Numerous appreciations of this aspect of Hardy's work have already appeared, and this collection of his papers must have an immense interest for those engaged in the exploration of the problem "Why and how a cell divides." His earlier work on biological subjects opened a wide and fruitful field of researches on colloids which have familiarised his name to us. The physical problems raised by the study of living matter led Hardy to abandon the current theories of the structure of protoplasm and the prevailing methods of its investigation by fixing and staining the cell. He resorted to study simple colloidal solutions and the results have established the connexion between electric charge and stability, the reversibility of sol-gel transformation and the recognition of globulins as types of colloidal electrolytes. Modern Colloid Science owes a great deal to these investigations and the concept of the colloidal electrotype has added to it a new and illuminating chapter.

In his Guthrie Lecture on "Some Problems of Living Matter," Hardy expounded that the available energy of a dead colloid or of an interface is in the main physical in character, while that of living matter is essentially a chemical potential, which gives way in the response to a stimulus, and is restored by an intake of oxygen. "The activities of a living cell appear to be due to a cunning combination of the chemistry of the dead space with the hysteresis of the colloid." Speaking later at the Colloid Symposium at Toronto in 1928, he observed "my thesis soon narrowed itself down to the ungrateful task of displaying the difficulties of the problem, and as a first step, let me state a belief which I have held for thirty years or more. It is that nothing is to be gained by claiming living matter as colloidal." It is true that the mechanical side of the interpretation of life phenomena requires a deeper understanding of molecular physics, but will such a knowledge alone provide us with an exhaustive picture of the manifold implications of what we call life. In the concluding part of his address Hardy has given a picture of his ideal of a Biological College. "It should have three floors, a ground floor of molecular physics, a first floor of biophysics and a top floor for cell mechanics. And of the staff the professor of molecular physics should have no responsibility for biology, the professor of biophysics should be a Mr. Facing-both-ways, responsible to physics and to biology, whilst the professor of cell mechanics should be a biologist pure and simple. That College I should expect to provide the new synthesis of knowledge of which biology stands in need."

Holding such views during all his period of work, he was led to investigate new problems regarding the static friction between solid faces of films of lubricant, when they are sufficiently near to each other to influence its physical properties. His researches on "boundary conditions" led him to establish facts far beyond their original scope, and provided problems in the properties of films on solid surfaces and

those of liquid films on liquids, for further study and investigation.

In his Abraham Flexner Lecture (1931) Hardy expresses his mature ideas regarding what he calls the greatest of the many improbabilities of living matter, and the momentous inference he draws from it. By virtue of its asymmetric powers of producing optically active compounds from symmetrical substances, living matter "seems able to evade an enormous mathematical improbability", *viz.*, in the first photo-synthesis of carbon dioxide and water to formaldehyde, the chloroplast contrives to catch and hold three quanta at once, and in this it is unique, for no known endo-thermic photochemical reaction involves more than one quantum. The dynamical systems in the living cell are produced by the capacity of the amino acids interacting with its molecular asymmetry. Asymmetry of living substance is specific and constant, but the barrier separating the asymmetric and symmetric world is not absolute as is proved by the synthetic products of the laboratory. To the question "how was the first asymmetric molecule created", Hardy seems inclined to think that "the beginning of life was an unique event at any rate in world history. There must have been a definite creative period whose duration does not concern us and whose character in three dimensional chemistry is a mathematical improbability." That there is something beyond physics and chemistry is envisaged by the cautious adoption by Hardy of the hypothesis of a special vital force and "the search for it is as likely to lead to our goal as any other." He would even go further and say "that the physical and chemical improbabilities of living matter are so great as to make an hypothesis of special creations more restful and almost as valid as that of continuous evolution." Hardy declares that he is not shocked by vitalism, but only he is afraid of it as a dangerous flag to fight under; it is, however, refreshing to read this preg-nant sentence,—"Is there any guess which comes within whooping distance of the shifts and tricks by which the primordial slime clothed itself in diffraction gratings to give the birds the colour they need in a tropical forest."

Within the limited space at the disposal of the reviewer, it is almost impossible to attempt anything more than bare notice of the work of a great scientist who has browsed far and wide in new and fresh pastures. His work is distinguished by a spacious dignity and a classic breadth of outlook, rare in these days of hurry and specialisation. Every scientist interested in the problems of biology and chemistry is deeply indebted to Professor Eric Rideal for his task of publishing this volume under the auspices of the Colloid Committee of the Farady Society assisted by the Dominion Governments of Australia, South Africa and New Zealand, the Royal Society and the Chemical, Biochemical and Physiological and Faraday Societies, in collaboration with the Master of Fellows of Gonville and Caius College.

Theoretical Astrophysics. By S. Rosseland. (Clarendon Press, Oxford.) 1936. Pp. 355. Price 25*sh.*

The appearance of a text-book on Astro-physics by so eminent an authority as Prof. Rosseland will be welcomed by all students of the subject. To those who are acquainted with his excellent little German book of 1930 *Astrophysik auf atomtheorctischer Grundlage* the present book and the planned second volume will serve as the fulfilment of the hopes cherished by them of the appearance of a regular text-book on Theoretical Astro-physics. In the older book, the order of topics treated was stellar interiors, stellar hydrodynamics, stellar atmospheres and finally gaseous nebulæ. In the present work, Professor Rosseland has partially reversed the order by treating in the first volume the subjects of stellar atmospheres and the outlying portions which he calls envelopes while reserving for the second volume the study of stellar interiors. There is no doubt that this is the most logical method of development from the learner's point of view. Another innovation in the present volume is the foundation of atomic physics that it is laid out in the first eight chapters so that the superstructure may be well and truly built. The topics dealt with in these eight chapters have been carefully and deliberately chosen with an eye on future application in astrophysical problems. While this has its undoubted advantages, it has also resulted in a rather condensed treat-ment and makes difficult reading in certain places, specially in the second chapter devoted to statistical mechanics. The idea of devoting a separate chapter to Dirac's theory of radiation is an excellent one and for a student of Astrophysics no better

account of it can be given than what is contained in the eighth chapter.

Chapters nine to eighteen are devoted to the essential developments relating to the lower atmospheric strata wherein thermodynamic equilibrium holds good. The remaining chapters are devoted to the highest atmospheric layers.

It may be said at once that this work is not meant to be a comprehensive treatise but a programme which the author has chalked out for introducing a beginner into the subject. Stress is therefore laid more on the underlying principles than on the actual details of several investigations and this makes the book all the more valuable for purposes of study.

Not the least interesting part of the book is the beautiful introduction of nine pages. It supplies the necessary historical background and no one who has read it will fail to see at once the great enthusiasm of the author for his subject. What is most gratifying to Indian readers is the very handsome tribute paid to the fundamental contributions of Prof. Megh Nad Saha to stellar spectroscopy. (We might incidentally notice here the curious misprint on p. xvi "Megd" instead of "Megh".)

Prof. Rosseland has rendered a great service to students of Astrophysics in bringing together in a collected form the latest developments of the several branches of Theoretical Astrophysics. We keenly await the appearance of the second volume.

B. S. M.

Short Wave Wireless Communication. By Ladner and Stoner. (Chapman and Hall, London.) 1936. 3rd Edition, revised and enlarged. Pp. 453. Price 21*sh.*

Since the publication of the first edition in 1932 this book has become so well known that a general review of the work as a whole is superfluous. The third edition now issued is a revised and somewhat amplified version of the second edition which appeared in 1934.

The chapter on Aerials is considerably enlarged and includes revised paragraphs on the effect of earth conductivity and a brief account of high frequency measurements of earth conductivity and dielectric coefficient.

A new chapter is added on commercial wireless telephone circuits, the practice in this branch of radio engineering being considered to be now sufficiently stabilised to warrant a text-book account.

New matter includes a discussion of the method of frequency modulation employed as an antifading device in telegraphy; and a description of appropriate circuits for putting the method into effect is appended.

In the four years since its first appearance the book has become indispensable to students of radio-communication. That this is widely recognised is attested by the fact that this third edition represents the sixth printing in this short period.

The printing and get-up of the volume are similar to those of the second edition and are excellent.

E. P. M.

Electrical Handicraftsman and Experimenter's Manual. By Langman and Moore. (Technical Press, London.) 1936. Pp. 192. Price 7*s.* 6*d.*

I consider that this book is not suitable for serious review in *Current Science*.

This is a book not easy to classify. It is claimed to be a "manual," a *vade-mecum* for electrical handicraftsmen, students, experimenters and inventors. From this one might expect a compendium of useful information arranged for convenient and constant reference, for those classes of readers.

Actually the book is very discursive and built, apparently, to no definite plan. It contains a good deal of information, some of it more curious than useful, on mechanisms and devices. It is conceivable that some of these might be turned to account by a worker faced with a practical problem. This information is conveyed in what is really a series of notes, illustrated by some excellently drawn diagrams, which may be regarded as the book's most valuable feature. A good deal of space seems to be wasted over devices of long obsolete types (such as, for instance, soleniod motors); and on models designed to illustrate simple principles which appear to be inappropriate to a manual for handicraftsmen, experimenters and inventors, or even for any but the most elementary of students.

In some instances these models hardly achieve their ostensible purpose. For example, on page 174 we find an account of an "electromechanical contrivance for correlating principles involved in mercurial and aneroid barometers." This turns out to be an arrangement (or rather two arrangements) for relating rectilinear motion to circular motion and so comparing a straight with a circular scale by means somewhat reminiscent of the school of practice associated with the name of Mr. Heath Robinson.

The book is well turned out as regards printing, illustrations, paper and binding.

E. P. M.

INDUSTRIAL OUTLOOK.

Problems of the Leather Industry in India.

By Rai Bahadur B. M. Das, M.A. (Cal.), M.Sc. (Leeds).
(Superintendent, Bengal Tanning Institute.)

LEATHER is now an important item of trade. It has multifarious uses. A large amount of it is consumed in the equipment of the Army and the Police Forces of the country; its consumption in making shoes, travelling requisites and various kinds of leather articles is very large. A considerable quantity is required in mills, factories, workshops and railways for various mechanical purposes. With the advancement of modern civilisation the scope of its utility is continuing to widen and its importance and indispensability in many of the activities of human life of the present-day world has been firmly established.

Hides and skins, primarily of the domestic animals, *e.g.*, buffalo, cow and oxen, goat and sheep, etc., which are bred and reared in every country for farming and food are the chief raw materials for making leather. Their supply is fairly large and regular. The ever-increasing demand for leather has, however, made it necessary to tap other resources and now skins of wild and aquatic animals are appreciably supplementing the hides and skins of domestic herds to satisfy this demand.

Hides and skins kept raw as obtained from the backs of animals, rot and decay in a short time. Different treatments, physical and chemical, are needed to stop putrefaction and to convert these putrescible animal products to leather suitable for human use. The processes are called "curing" and "tanning" respectively. The methods that are in vogue to-day, have evolved to their present stage through thousands of years' practice and experience. There must have been innumerable trials and experiments. The failures have been forgotten. Only those which yielded satisfactory results have survived and have been handed down to us.

No human art or occupation can indeed claim such antiquity as the art of leather-making. It is much older than agriculture, for it is now universally recognised that long before men learnt to till the soil, they used to live by hunting. And it must have occurred to the primitive hunters to use the furs of the animals they bagged for clothing as a protection against cold and rain. It must have also been noticed by them that kept as such the skins did not remain sound. Drying in the sun would no doubt help in their preservation but it made the skins too hard for use. Hence they must have tried to soften the skins while drying by applying the fat of the very animals they bagged whose emolient action they must have previously observed on their own skins. Thus originated the early method of dressing skins with the wild tribes in prehistoric times, which may be called the precursor of modern tanning. This method of tanning with animal fat in a modified form is practised even to-day, and is known as oil tannage by which the well-known chamois leather is made even now.

Use of vegetable matters such as barks, fruits and leaves of trees in tanning, is of much later origin, and that of mineral substances such as alum and salt belongs to a still later date, while the application of chrome salts for tanning is quite a modern invention.

Tanning attained considerable development in ancient Egypt. An Egyptian granite carving showing leather dressers at work, believed to be 4,000 years old, is displayed in the Berlin Museum. Old records show that tanning was practised in ancient times in China and India.

In Europe tanning was understood by the ancient Greeks and Romans but the development was slow and the art remained practically stagnant till the 19th century A.D. From the early times till the last decade of the 19th century the principal method used was that of tanning with vegetable matters. Methods were all rule of thumb, the principles underlying were not well understood and much secrecy was observed by successful manufacturers. The art was in short empirical.

Modern science, which has resuscitated so many arts from empiricism, was not long unmindful of the art of leather-making; chemical, physical and bacteriological sciences soon explained many unseen phenomena of tanning and clearly exposed the principles underlying it. Mechanical Engineering replaced many slow, though in some cases skilled manual labour, by many time- and labour-saving machinery. Empirical rules, rule of thumb ways, and the so-called trade secrets were swept away before the

flood of scientific knowledge. The modern art of tanning is now almost an exact science and leather manufacture a chemical industry.

The leather industry has immense possibilities in India. In respect of resources of raw materials, *e.g.*, raw hides and skins, India's position is very high among the different countries of the world. Out of the 600 million cows and kips of the world India possesses about 160 million. Of the estimated 47 million heads of world's buffaloes, India has about 34 million ; of the 203 million goats, India claims 53 million and of the total 575 million sheep and lambs in the world the estimated share of India counts 41 million. The annual supply of hides and skins from this huge live-stock has been estimated by Arnold as under :—

Cattle hides	.. 20	million pieces.
Buffalo hides	.. 3.5	do
Goat skins	.. 22.0	do
Sheep skins	.. 11.5	do

Besides, the jungles in India are proverbially full of snakes and lizards and there is no dearth of crocodiles in her waters. The skins of these wild and aquatic animals have of late been turned into normal trade commodities.

All these available hides and skins are suitable for the manufacture of nearly all varieties of leather that India needs at present. Her cattle hides produce a shoe upper leather of medium and cheap grades suitable for the shoes of middle and poor classes of her population, while her goat skins, which in quality are among the best in the world, and produce the finest kind of upper leather can be used in the making of shoes for her rich and classy people and the ladies. The sheep skins produce the lining leather and the buffalo hides supply the leather for soles and insoles of boots and shoes and for multifarious industrial purposes. The cattle hides also produce leather for trunks, suit cases, bags, straps, belts, etc., and the sheep, goat and reptile skins produce excellent leather for fancy and luxury articles. Upholstery leather can be made from cattle hides, goat and sheep skins.

India is well provided with many vegetable tanning materials. Three of them at least have a very wide use. These are babul bark (*Acacia arabica*) of Northern India, avaram or tarwar bark (*Cassia auriculata*) of Southern India and myrobalans (*Terminalia chebula*). These materials have been in use in the Indian Tanning Industry for quite a long time, and have been found to produce excellent tannages. As a matter of fact tarwar bark is one of the best tanning materials known, in respect of excellence of colour it produces on leather and the speed with which tanning is effected. Its supply, however, is not quite adequate. The supply of babul bark, on the other hand, is still ample, steady and reliable. Babul produces leather almost similar to the British Oak tanned variety. India not only produces all the myrobalans she requires but exports a considerable quantity to foreign countries.

Notwithstanding the various advantages mentioned above, the leather industry in India has not developed to that extent as one should expect. The causes are threefold (i) social, (ii) economic and (iii) technical. An attempt has been made to explain the difficulties under these heads in the following paragraphs in order.

Social.—To the Hindus who constitute the bulk of the Indian population, raw hides and skins are abhorrent. The very sight of a slaughtered cow gives a rude shock to their religious sentiments and even the touch of those who deal in raw hides and skins, is considered by many as pollution. Under the circumstances, the raw materials were left from time immemorial in the hands of an illiterate depressed class, called "chamars". Neither the trade in raw hides and skins nor the art of leather making could, therefore, develop until the attention of foreigners was drawn to them. If we have been indifferent from our extreme religiosity and snobbish sentiments, others were alert and saw in the Indian hides and skins vast potentialities.

Formerly in India hides and skins were the property of the village chamar who flayed the dead animal and tanned the hide or skin to supply local needs for leather. But as these needs were limited, much of the available raw materials were left uncared for and wasted.

Demand of Indian hides and skins from countries abroad created an export trade which developed steadily. This appreciated their value considerably. Records show that in 1846 the average value of an Indian cow hide was only 7as. 5p. and of a skin 3as. 2p. while in 1912–13 the average value of a cow hide rose to Rs. 6 and that of the skin to Rs. 1–9–6. This rise in the price gave an impetus to the better care and collection of hides and skins and the value of their export trade increased by leaps and bounds. In 1912–13, that is to say, just before the World War it rose to about 12 crores of rupees.

The post-War trade depression which depreciated commodity prices reduced the values of Indian hides and skins also. At present the average value of an Indian cow hide is about Rs. 3 and of a goat skin Re. 1.

Economic.—India is regarded as a surplus country in respect of hides and skins. So is she in her present condition, but if the standard of living of her people is raised, all the hides and skins available in the country will not be sufficient to provide the 320 million Indians with even one pair of shoes per head per annum. Besides shoes, leather is also required for many industrial purposes. This must also be supplied so that India may pursue her industries.

The Indians have got a very small purchasing power, and therefore, they have to forego not only many amenities but also many necessities of modern life. Shoes are not only a part of civilised dress but they are also necessary on hygienic grounds. In India only a few can afford to buy shoes and millions go about bare-footed as they have got no money to buy footwear. The poverty of the Indian people is a source of great weakness not only for the Indian Leather Industry but also for many other industries. Unless the home market is strong, industries have very little support to rest on. For, to sell finished products in foreign markets one has to surmount several barriers, and the tariff walls in many countries are almost insurmountable.

The foreign demand for Indian hides and skins exerts considerable influence on the local tanning industry. When this demand is large Indian tanners cannot buy their requirements of hides and skins at prices they can afford to pay. At such times the bulk of the hides and skins is exported. The local tanners get only the portion left over after the exporters have been satisfied.

Before the War the Germans were the keenest buyers of Indian cattle and buffalo hides and the Americans of goat skins. The export of these materials was so heavy that Indian tanners could hardly get sufficient raw stocks for local tanning.

The adverse effects of unfettered export of raw hides and skins on the local tanning industry was first noticed during the last Great War. Large quantities of leather were required for war purposes which the Indian tanning industry was called upon to supply. The importance of the conservation of raw hides for tanning and development of the tanning industry in India and within the British Empire were then realised.

Export duty on raw hides and skins.—With the above objects in view the Government of India imposed an export duty of 15 per cent. on the export of raw hides and skins with the provision for a rebate of 10 per cent. in case the exported hides and skins were tanned within the British Empire. The 15 per cent. duty, however, had a very short life. The Fiscal Commission of 1921–22 condemned the export duty on hides but retained a small duty on skins. The Government of India, however, reduced the 15 per cent. preferential duty to one of a flat duty of 5 per cent. for all countries in the year 1923. There was good deal of controversy over the hide export duty. It was extremely unpopular with the raw hide exporters, but local tanners found in it a brake on the uncontrolled export of a material on which their living depended. As a result of persistent agitation the export duty on hides and skins has been abolished.

For a long time the raw hide export trade made tanning in India a highly speculative business. Local tanners were not sure what the prices of their raw materials would be, say, after a week or a fortnight. In sympathy with the foreign demand the prices might soar up or climb down. It was difficult for them to buy hides in large quantities or to effect large sales of leather in advance. There was a limit upto which they could pay for hides and for tanners who sold their products in the internal markets, this limit was imposed by the purchasing power of their customers in India. If the limit was exceeded the customers refused to respond. The exporters on the other hand sold in markets where the purchasing power of the people was greater than it was in India and therefore could afford to pay higher prices than Indian tanners.

For several years right upto the War it was the exporter who won in this competition, but the War changed the economic conditions of the countries which used to buy Indian hides and skins. Their purchasing power dwindled. Europe and America have not been buying quite as many hides and skins during post-War years as they used to do before the War. The result has been that more hides and skins are now available for local tanning at prices which the Indian consumers can afford to pay. The Indian Tanning Industry thus got the chance to grow and develop, and it has not let the opportunity slip.

The present tanning industry in India falls into three sections, the crude country tanning, the half tanning and finished leather tanning.

Crude-Tanning.—Crude-tanning is done by innumerable chamars in villages throughout India and the crude leather is used for making the various types of indigenous footwear, *e.g.*, Nagra and Munda shoes, slippers, chappals, etc., which are mostly worn by the poor rural population. Considerable quantities of this crude leather is also used for cheap harness and saddlery and water-bags (Mashaks). The out-turn of this crude leather is quite considerable but accurate statistics is not available. This type of tanning badly requires improvement but it is a real problem how to effect it. The solution lies in the introduction of modern improved processes into India's rural tanning but the poverty and illiteracy of the village tanners make this introduction extremely difficult. It is necessary to bring both capital and education to bear upon this section of Indian tanning. Attempts in this direction are being made by the Departments of Industries of some of the Provincial Governments. In Bengal, two peripatetic tanning demonstration parties are maintained by the Government under the Department of Industries. The parties are attached to the Bengal Tanning Institute. They give demonstrations of modern tanning methods in villages over one to two months at a place. Village chamars as well as educated youngmen of the higher castes are admitted as students in these classes. After training, the youngmen are encouraged to start tanning on a small scale using modern methods in the villages and small towns. In this way a number of educated middle class youths have been trained up, some of whom are engaged in tanning in rural areas. Chamars have also been taught modern methods of work and some of them are using these methods in preference to the crude processes handed down to them by their forefathers.

Governments of the Punjab and Bombay have also started such demonstration parties with the object of improving crude tanning in rural areas.

Half Tanning.—The half tanning industry is the largest section of the Indian Tanning Industry. It is carried out in Madras and Bombay and its annual production is worth about five crores of rupees. The half-tanned leather is exported from India. Bulk of it goes to England and smaller proportions to such other countries as America and Japan, etc. Only the very inferior selections, *viz.*, the rejections and double rejections, are sold in India.

The location of the half tanning industry in Madras and Bombay is due to the occurrence in these provinces of avaram bark which is very suitable for making half-tanned leather. For a long time this bark was exclusively used for the production of half-tanned leather but since the War it has been partly replaced by wattle bark imported to Madras from South Africa. At present cow and buffalo hides are tanned with wattle while goat and sheep skins with avaram bark.

The process of half tanning is entirely indigenous and the method is rule of thumb and more or less crude. The product, however, is satisfactory to those who buy it. Improvement in this branch is, therefore, not so urgent in regard to quality but to methods of work which appear to be wasteful. Scientific control is expected to reduce the wastage and cost of production by saving time, labour and materials. Pointed attention of tanners engaged in this important branch of Indian leather industry is drawn to the advantage of harnessing science to service. Period of liming which according to present practice varies from 7 to 20 days can be shortened considerably by sharpening lime with sulphide depilatories. The present tedious practice of removing lime by repeated tramplings and beatings in several changes of water can with advantage be replaced by quicker methods of deliming with weak acids and enzyme bates. According to present practice about $\frac{1}{3}$ of the available tannin in the avaram bark and $\frac{1}{4}$ in wattle are lost in the spent tan through inadequate extraction which can be prevented by adoption of recognised methods of extraction of tanstuffs. Good deal of stains which appear on the half-tanned leather in the present method of work can be avoided by substituting the contact process of tanning by the liquor method. Initial attempts of the introduction of these reforms to the time old process may encounter difficulties but they are sure to yield to sustain the efforts as has been the case in Western countries where tanning has been elevated to the position of a scientific industry as opposed to an empirical craft. It is high time that the half tanning which had better be called crust tanning were modernised and freed from antiquated and wasteful methods of work.

Finished Leather.—The manufacture of finished leather has been making rapid strides in India. This divides itself in two

broad classes: the bark tanned and chrome tanned. The former consists of sole, harness and saddlery, ammunition boot upper, suitcase and bag, morocco, printed goat, coloured sheep, coloured calf, suede and reptile leathers. These are mostly made for internal consumption, a proportion of the sole leather only being exported.

It is in the manufacture of chrome-tanned shoe upper leather that the bigger tanneries in India are engaged. These leathers are black box sides and calf, brown or willow sides and calf, and black and brown glace kid. Black and willow sides are manufactured from cow hides, box and willow calf from calf skins, and glace kid from goat skins. Successful manufacture of these leathers requires good deal of technical knowledge, scientific control and a number of machines. The tanneries in India which are engaged in their production are more or less adequately equipped with the required machinery and have in their employ trained experts, technical assistants and machine operatives. Almost all the experts are either foreigners or Indians who have had training in the manufacture of leather and in leather chemistry in foreign countries. The technical assistants are mostly trained students of the Bengal Tanning Institute and Leather Trades Institute of Madras. Some have been trained up in tanneries starting as apprentices. Machine operatives are all Indians who have been trained in the tanneries.

Indian box sides and box calf have been improved in quality to a great extent through the efforts of the commercial chrome tanneries and by the researches and investigations of the trade institutes like the Bengal Tanning Institute. The Indian products are now being sold in overseas markets in competition with foreign leathers. The Ottawa Agreement gave a great impetus to the export of this leather to the United Kingdom. About 26 lakhs of rupees worth of box sides and box calf was exported from India in 1935. Before the Ottawa Agreement this export was practically nil. The Agreement, therefore, helped the Indian chrome leather industry to a very great extent.

A few tanneries in India are also manufacturing glace kid from Indian goat skins. The product is sold in India and a large proportion is also exported. The quality of the Indian glace kid has been greatly improved and no difficulty is being experienced in marketing it in foreign countries.

Among other varieties of chrome leather manufactured in India may be mentioned chrome sole leather, picking band and lace leather. Picking bands are used in textile mills. Large quantities of these bands are still imported. The annual value of the import of picking band is about eight lakhs of rupees. This import shows that there is a great deal of scope for the manufacture of picking bands in India.

Chrome laces are used for stitching machine belts and are required in all types of factories using belt drives for running machines. Tuggers, taper bands, leather springs for looms are also made from locally manufactured chrome leather.

Apart from its use in sandals and chappals chrome sole is also utilised in making ginning washers for which there is a large demand.

Fancy Leather.—Manufacture of finished light leathers (fancy leather) has not yet been taken up on any large extent in this country although a great bulk of the light leather is manufactured in Great Britain, Germany and other countries from the tanned goat and sheep skins exported from Madras and Bombay. Roller skins are an important variety of light leather required for industrial use in textile mills. These are all imported. The annual value of the import of roller skin is about seven lakhs of rupees.

In spite of what is being done the finished leather industry has not developed in India to the extent her raw materials and resources justify. The reason for this is the very small consumption of the finished leather, in this country. The purchasing power of the Indian masses is proverbially poor. They can only afford to buy cheap and crude leather and yet cheaper leather substitutes.

The way to foster the finished leather industry in India is to make suitable fiscal arrangements with those countries which now import Indian raw hides and skins and rough tanned leather. These countries should be made to take at least a quota of the Indian finished leathers without imposing prohibitive duties on them as they do now in consideration of the help that India renders them by supplying the raw materials on which they so largely depend for their leather industries. The Ottawa Agreement has been a great eye opener in this direction. Due to the preference given to the Indian chrome leather in the United Kingdom a phenomenal development of the chrome leather industry has resulted during the operation of the Agreement. Similar developments are possible in other branches of the industry under equally favourable fiscal arrangements in their regard.

International Chemical Engineering Congress of the World Power Conference.

THE above Congress, the first of its kind, was held in London at the Central Hall, Westminster, from 22nd June to 27th June 1936 and was attended by delegates and members—representing forty nations—from all over the world. There were nearly 800 members of which nearly 450 were from Great Britain, 150 from the United States of America and a good number from Japan and Germany. On account of the Italo-Abyssinian War and its repercussions on the public opinion abroad, there was only one member from Italy.

The choice of the venue for the Conference was a very happy one, not only on account of the large space available at the Central Hall but also on account of its proximity to such historical places as the Westminster Abbey, the Houses of Parliament, Whitehall Offices and not far from the Buckingham Palace.

The meeting of the Chemical Engineering Congress coincided with the visit of the American Institute of Chemical Engineers to the Institution of Chemical Engineers of Great Britain. His stature and official position made Dr. Ittner, the President of the American Institute, conspicuous at every function.

Of the many distinguished visitors from the United States, particular mention may be made of Dr. L. H. Baekeland, of the Baekeland Corporation, who needs no introduction on account of his bakelite fame. He is a very kindly unostentatious man with charming personality and easy manners, young in spirit, though older in years and always ready with amusing anecdotes. Even his visiting card, which is too small to hold all the honours and distinctions conferred on him, thus making it necessary to accompany it with a long separate supplement, is not without its humour. "Dr. L. H. Baekeland, "Snug Rock", Harmony Park, Tonkers-on-Hudson."

Another visitor who attracted much attention was Professor Ushkevitch, Director of a Technical Institute at Moscow, U.S.S.R.

As is to be expected at such an international gathering, one could not help hearing a large number of languages in the lounge and elsewhere.

Let it be stated at the very outset that the Congress was a great scientific and social success and the credit goes to the organisers—many of whom were drawn from the Institution of Chemical Engineers—for every detail that had been carefully thought out and worked.

The idea of holding such a congress originated with the late Sir Frederick Nathan and every one regretted that he was not spared by Providence to see its fruition.

The Congress was opened by his Royal Highness the Duke of Kent on the afternoon of Monday, the 22nd June, with Lord Leverhulme, the President of the Congress, in the chair and with the heads of the delegations and representatives on the platform.

His Royal Highness said that it was now twelve years when his brother, the King, then Prince of Wales, opened the First World Power Conference at Wembley. Many of the high hopes of which he spoke then, had since been realized and the World Power Conference by means of meetings which it held in various parts of the world had proved itself effective in securing international co-operation between engineers, technicians and administrators. Next September there was to be a Third World Power Conference in Washington at the invitation of the United States Government.

Extending a warm welcome to all the overseas delegates and members, His Royal Highness said proud as each country was of her great scientists and inventors, their work once done became international and contributed to the welfare and happiness of every race. This century had seen the development of science more rapid, more wide and more fundamental than in any previous age. No profession had been more ready or more skilful than their own in using all the resources science could offer. With the opening of that first international conference it came of age.

Chemical Engineering had made such progress that it has entirely altered the meaning of the word "artificial". At one time artificial implied some measure of inferiority but to-day there was no such stigma attached to its modern equivalent 'synthetic'. Their success had been achieved by the union of the engineer and the chemist. He had always been amazed at the skill with which the engineer had enabled chemical reactions to be carried out on a gigantic scale, with certainty of control and under conditions for the workers which contrasted so favourably with those of the past. It was an achievement of which they, as chemical engineers, might well feel proud.

He wished them success in their deliberations and he hoped that they would carry away happy recollections of those few days spent in London and that the effects of the meeting would extend far beyond the technical confines of their immediate discussions.

After thanking His Royal Highness, the Duke of Kent, for opening the Congress, Lord Leverhulme proceeded to deliver his presidential address.

Nearly 127 papers were presented to the Congress and only a few of them were discussed in the meetings during the next four days.

For the sake of convenience, the above papers were classified into the following thirteen sections covering an astonishingly wide range of subjects:

(*a*) Ferrous Metals in Chemical Plant Construction. (*b*) Refractories, Rubber, Plastics and other Materials in Chemical Plant Construction. (*c*) Separation by Washing, Filtering, Distillation, etc. (*d*) Size Reduction, Grading and Mixing, Electrolysis and Electrical Applications. (*e*) Destructive Distillation. (*f*) Treatment and Disposal of Effluents and Waste Materials; Lubrication. (*g*) High Pressure Reactions and High Vacua. (*h*) Heat Exchange. (*i*) Education and Training. (*j*) Statistics: Administration; Safety and Welfare. (*k*) Trend of Development. (*l*) General Aspects.

There was a General Reporter to each section and he presented very ably a concise and very lucid account of the important or striking features of the papers in his section and added his own comments on them. The meeting of each section lasted only an hour and a quarter so that there was not much time available for discussing the papers.

It would not be fair to single out any paper or set of papers for special mention. Reference may, however, be made to a paper entitled "Underground Gasification of Coals" by Chekin, Semenoff and Galinker from U. S. S. R. on account of its novelty.

The authors state that the great cost of the operations associated with the mining of coal can be largely eliminated by gasifying coal underground, the gas being used for generating electric power or transmitted through pipe lines.

The idea of underground gasification was mentioned by Mendeléef in 1888. In 1931, the Russian Government granted a subsidy to their technical men to carry out large-scale experiments to attain the goal.

As a result of investigations, two new schemes have been adopted for the basis of further work. One instance is given of the Gorlovka Mine which has been operated since 1935 on blows supplied periodically. The gas produced during the air blow is named ' power gas ' and is suitable for combustion and heating supply. At present the mine yields 25,000–30,000 cubic metres of power raising gas per 24 hours, and 12,000–15,000 cu.m. of gas for chemical use. The length of each period with and without air-blow varied from 4 to 6 hours. This method is stated to be simple and inexpensive. The authors conclude by stating that underground gasification of coal offers a wide field of action for investigators, engineers and designers.

The closing meeting of the Congress was held on the morning of Saturday, the 27th June, with Sir Harold Hartley, the President of the Third World Power Conference, in the chair. The chairman of the Technical and Organising Committees spoke and were followed by the valedictory speeches from some of the overseas delegates. Lord Leverhulme thanked the Duke of Kent for His Royal Highness's patronage and His Majesty's Government for the encouraging and admirable support which they had given to the Congress.

Finally, Sir Harold Hartley mentioned in his closing speech that the German delegation had extended its invitation to the Congress to hold its second meeting in Berlin in 1940.

In addition to the above meetings, visits were organised on two afternoons to Chemical Engineering Laboratories, Fuel Research Station, Chemical Laboratories at Teddington and to some factories in and around London. These were well patronised and the management everywhere spared no efforts to make the visits very pleasant, enjoyable and instructive for the membrse.

The social side of the Congress was very well attended to. There were several official luncheons, dinners and a banquet at the Grosvenor House. At the banquet, Lord Rutherford, in proposing " The Chemical Engineering Congress " urged that pure science should be given a free hand in the future in order that industry might thrive. Sir David Milne Watson, Chairman of the Organising Committee, who responded, said that all nations had a common bond in science and the hope of the future world peace was to be found in the *rapprochement* of the nations in scientific matters. In proposing " Our visitors from Overseas," Mr. Macdonald, Lord President of the Council, said that chemical engineers were not only building the economic foundations of a new generation but were uniting, in a way that had never been done before, pure science with industry. They were raising industry to a new intellectual and spiritual level and were giving it a new technique.

During the Congress Week but entirely separate from its activities was held the Fourteenth Dinner of the Institution of Chemical Engineers at which members of the American Institute of Chemical Engineers and the heads of overseas delegations were entertained, Captain Evan Wallace, Secretary of the Department of Overseas Trade, being the principal guest. There were the usual after-dinner speeches by the principal guest, Dr. Levinstein, the President, and many others present.

Three receptions were held in connection with the Congress: the first at the Dorchester Hotel where Lord Leverhulme, the President of the Congress, received the guests; the second was held at the Lancaster House by His Majesty's Government, Mr. Ramsay Macdonald and his daughter, Miss Ishbel, receiving the guests; and the third was held at the Imperial Chemical Industries House in Milbank where Sir Harry and Lady McGowan received the guests. This last reception was a very grand one. The ballroom, the Directors' rooms and other offices were all open to visitors for inspection and there were industrial films being shown all the time. Some of the Company's products were displayed in the Exhibition Room in a very attractive style. Refreshments and drinks were provided on a very sumptuous scale and every one seemed to enjoy this reception most.

This Congress enabled its members to renew old friendships and to make new acquaintances. It gave them an excellent opportunity to discuss their problems with one another and to invite valuable comments on their views and methods from their colleagues working in the same field.

British Chemical Plant Exhibition.

THIS Exhibition, held by the British Chemical Plant Manufacturers' Association concurrently and at the same place as the Chemical Engineering Congress, was opened by the Rt. Hon. Mr. Ramsay Macdonald on Monday, the 22nd June, at the Central Hall, Westminster.

Mr. Monnypenny, the Chairman of the Association, said that, that Exhibition, the third of its kind—the other two having been held in 1926 and in 1931—showed what a great progress the British manufactures of chemical plant had made in this direction in the post-War years. In order to qualify as British, at least 75% of the cost of production—including material and labour—of the plant must be British or of Empire origin. He laid emphasis on the closer co-operation between the chemical manufacturer and the chemical plant manufacturer and said that, so far as he knew, the confidence of the former had not in a single case been betrayed by the latter.

Mr. Ramsay Macdonald, in declaring the Exhibition open, said that he was greatly impressed by the achievements of British chemical engineering one of the notable examples of which he saw in the plant for the conversion of coal into oil at Billingham. The aim of the Department of Scientific and Industrial Research with which he is connected *ex officio* as Lord President of the Council is to promote co-operation and interchange of ideas between the chemist, the physicist and the engineer.

Later, an inaugural lunch was held at the Hotel Victoria and was attended by a very large number of members of the Congress and guests. In proposing the toast of the British Chemical Plant Manufacturers' Association, Sir David Milne Watson, who is himself connected with a large chemical industry, *viz.*, the gas industry, laid emphasis on the need and value of making one's products known to the users by what was at one time known as propaganda but now goes under the name of "communication". Mr. Ramsay Macdonald in his speech expressed the hope that there would be closer co-operation between Great Britain, Germany and the United States in this field.

The Exhibition illustrated the wide range of apparatus and plant that is now available in Great Britain, not only for the chemical industries but also for the numerous others which utilise similar equipment. On its stands could be seen and examined the latest advances in chemical plant together with the host of appliances and equipment that are required to meet the demands of modern industry. In addition to the apparatus required for processes such as evaporation, distillation, drying, feeding, screening, sifting, etc., plants designed for filtering, pumping, separating, clarifying, emulsifying, etc., were also on view.

The stainless steels—called 'special' steels on account of their resistance to heat, rust, acids—were shown by their respective makers. The plant manufacturers have made them 'general' by their utilisation in the fabrication of equipment where contamination is undesirable. Of note amongst the corrosion resistant plant which included aluminium, etc., mention may be made of glass-lined equipment—which is, so to speak, the works counterpart of laboratory glassware—vitreous enamelled receptacles and the new white stone ware.

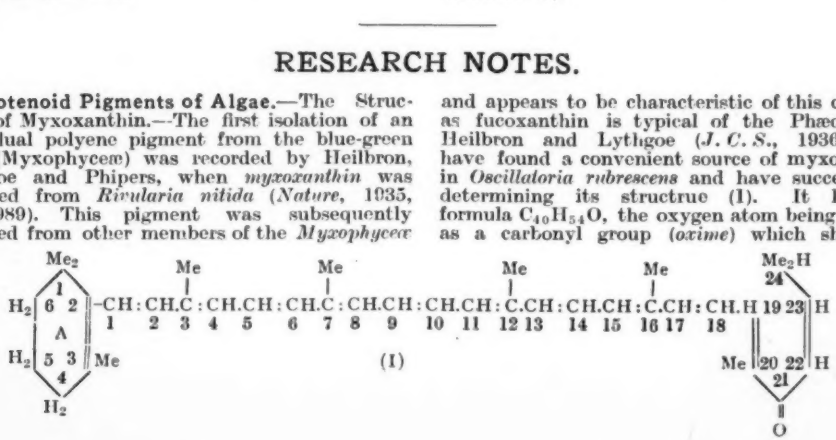
Instruments for the indication, control and recording of temperatures, pressures, humidities, hydrogen ion concentration, meters for various uses, pyrometers and many other essential means for the control of industrial operations were displayed in quantity.

The Industrial Research Exhibit—a very large stand organised by the Department of Scientific and Industrial Research—was very interesting and instructive. It was designed to show how this department aids British industry by applying the results of scientific research to its problems—a subject to which no progressive country could remain indifferent.

The exhibits were displayed in a very attractive manner and demonstrated the high quality of British workmanship. At all hours of the day, the stands were always crowded with visitors and their inquiries were promptly and courteously attended to.

RESEARCH NOTES.

Carotenoid Pigments of Algae.—The Structure of Myxoxanthin.—The first isolation of an individual polyene pigment from the blue-green algæ (Myxophyceæ) was recorded by Heilbron, Lythgoe and Phipers, when *myxoxanthin* was obtained from *Rivularia nitida* (*Nature*, 1935, **136**, 989). This pigment was subsequently obtained from other members of the *Myxophyceæ* and appears to be characteristic of this class just as fucoxanthin is typical of the Phæophyceæ. Heilbron and Lythgoe (*J. C. S.*, 1936, 1376) have found a convenient source of myxoxanthin in *Oscillatoria rubrescens* and have succeeded in determining its structrue (I). It has the formula $C_{40}H_{54}O$, the oxygen atom being present as a carbonyl group (*oxime*) which shows no



(I)

tendency to enolise. Quantitative microhydrogenation in decalin-acetic acid of the pigment and its oxime indicates the presence of 12 ethenoid linkages. It follows that myxoxanthin is monocyclic and is to be classed with γ-carotene and rubixanthin. Like γ-carotene, it contains an unsubstituted β-ionone ring since biological experiments with vitamin-A-starved rats show that it possesses growth-promoting properties. That the carbonyl group is conjugated with the polyene chain is shown both by the colour difference between solutions of the same concentration in light petroleum (yellow) and in alcohol (pink), and also by comparative spectrographic examination of myxoxanthin and its oxime. Reduction of myxoxanthin by aluminium *iso*propoxide gives the alcohol myxoxanthol, which is spectroscopically identical with both γ-carotene and rubixanthin. Myxoxanthol therefore possesses a chromophoric grouping of one cyclic and 10 acyclic ethenoid linkages in unbroken conjugation, and consequently in myxoxanthin a carbonyl group must be situated at C_{21} in a γ-carotene skeleton, the only possible alternative (at C_4, ring A) being excluded by the biological activity of the pigment. The unlocated ethenoid linkage may be $\Delta^{22\text{-}23}$ or $\Delta^{23\text{-}24}$, either position being compatible with the observed optical inactivity of myxoxanthin. A decision in favour of $\Delta^{22\text{-}23}$ has been reached by a comparison of the results of spectroscopic examination of myxoxanthin and of carotenoid pigments of known constitution. Characteristic of the class to which myxoxanthin belongs, is a single broad band as contrasted with the normal triplet spectrum of carotenoids having a carbonyl group terminating the chromophoric system. The conclusion is reached that the single-banded spectrum of such pigments is due to the simultaneous conjugation of the polar carbonyl group with two sets of unsaturated linkages.

Heilbron and Lythgoe have also isolated from *Oscillatoria rubrescens* a new pigment *myxoxanthophyll*, $C_{40}H_{56}O_7$ ($\pm$ 2 H), but in insufficient quantity to determine the structure. The tenacity with which it is retained by adsorbents indicated the presence of a multiplicity of hydroxyl groups. The absence of polar groups conjugated with the polyene system is suggested by the fact that the alcoholic solutions are coloured only yellow to orange red.

T. S. W.

Ultrafiltration by a Centrifuge Method.—The ineffectiveness of ultrafiltration technique in concentration of colloids is principally due to clogging of the ultrafilter membrane by a deposit of the disperse phase; this reduces the filtration velocity very much or even stops it altogether. Since even a thin deposit of the disperse phase is often quite effective in bringing down the rate of filtration, the incorporation of stirring or scraping devices does not help very much. Brinkman and Steinfoorn (*Biochem. J.*, 1936, **8**, 1523) have eliminated this difficulty by an ingenious device. The liquid to be ultrafiltered is kept in a small cylindrical unglazed porcelain pot coated with an ultrafilter membrane and centrifuged. The centrifugal force not only provides the necessary pressure for ultrafiltration but is also helpful in another way. Any peripheral part of the liquid which gets concentrated and hence increased in specific gravity is centrifuged towards the bottom and thus clogging is prevented. As the experiments show, comparatively large quantities of the ultrafiltrate are obtainable by this method.

K. S. G. D.

The Neutrality of the Neutron.—Chadwick's original proof that neutrons are unaffected by electric field were really made with fast neutrons. P. B. Moon (*Proc. Phys. Soc.*, 1936, **48**, 658) has carried out experiments with slow neutrons having thermal energies. The results show that the neutron possesses, if at all, an amount of charge much less than 10^{-7} times that of an electron.

K. S. G. D.

Routine Determination of Boron in Glass.—Francis W. Glaze and A. N. Finn in a recent paper (*J. Res. National Bureau of Standards*, 1936, **16**, No. 5) describe the procedure adopted and the results obtained by a new method for determination of boric acid in specimens of glass. The method depends on the "partition" of boric acid between water and ether in the presence of ethanol and hydrochloric acid. The partition coefficient can be calculated roughly from the relation $K = 0.673 - 0.054\sqrt{t}$ and is equal to 0.403 at 25 $\pm$ 2°. The boric acid in the ether layer is estimated volumetrically by titration with standard alkali.

A study was made of the extent to which the other elements present in glass interfered with the method. It was found that the usual amounts of lime, magnesia, alumina, soda, iron and arsenic did not interfere, but barium, fluorine and large amounts of iron interfered slightly. Zinc, however, was found to interfere seriously.

Amounts of boric oxide ranging from 0.7 to 16 per cent. could be estimated rapidly and accurately by this method.

K. R. K.

Absorption of X-Ray by Lead Glasses and Lead Barium Glasses.—By George Singer (*J. of Res. of the National Bureau of Standards*, March 1936, **16**, 3).—The object of this study was to determine the X-ray protective properties of flint and barium-flint glasses and to correlate them with their chemical composition as well as with their physical properties such as density and refractive index.

Adequate details are given of the experimental arrangement and procedure adopted.

The X-ray opacities of the materials were determined by an ionisation method. That thickness of lead which gave the same ionisation current as the sample was taken as its lead equivalent.

The results obtained enabled the formulation of several empirical relationships. In the case of flint glass, its protection coefficient was correlated to (*a*) density, (*b*) refractive index and (*c*) chemical composition, thus enabling the protection coefficient of a sample to be predicted from a knowledge of its density, refractive index or chemical composition. The values calculated from these formulæ were found to be in good agreement with the results of experiment.

In the case of barium-flint glass, an empirical relation is given between the protection coefficient and the lead oxide and barium oxide components of the glass.

K. R. K.

SCIENCE NOTES.

Vacuum Production.—The exacting demands of high vacuum technique in research and in laboratory practices are, to a large extent, met by the rotary pumps manufactured by the Central Scientific Company (Agents for India: The Scientific Instruments Co., Ltd., Allahabad). The latest and largest of these, the "Cenco Hypervac 100" represents a great achievement in the design and construction of pumps for high vacuum production. It is a completely self-contained 3-stage pump, with a displacement of 16 litres per second. It dispenses with the need for water cooling; and for working a pump of its size, has a small power requirement—1.5 H.P. Even at low pressure (1 micron and below), the pump is unusually rapid for an oil-sealed pump. It is already finding application in commercial practice for exhausting large vacuum chambers and in the research laboratory it will find numerous uses. The manufacturers cordially invite correspondence regarding the "Cenco Hypervac 100".

* * *

We acknowledge with thanks receipt of the following:—

"Bulletin of the National Academy of Sciences," Vol. 6, Part III, August 1936.

"The Agricultural Gazette of New South Wales," Vol. XLVII, No. 10, October 1936.

"Journal of Agricultural Research," Vol. 53, Nos. 2–3, 4.

"Monthly Bulletin of Agricultural Science and Practice," Vol. 27, No. 9, September 1936.

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"Biochemical Journal," Vol. 30, No. 9, September 1936.

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"Journal of Chemical Physics," Vol. 4, No. 10, October 1936.

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"Transactions of the Mining and Geological Institute of India," Vol. XXXI, Part 2, September 1936.

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"Science Progress," Vol. 32, No. 122, October 1936.

"Scientific American," Vol. 155, No. 5, Nov. 1936.

"Indian Journal of Venereal Diseases," Vol. 2, No. 3, September 1936.

"Indian Journal of Veterinary Science and Animal Husbandry," Vol. VI, Part III, September 1936.

Catalogues:

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"Monthly List of Books, on Natural History and Science," October 1936 (Messrs. Wheldon and Wesley, Ltd., London).

"Aids for Modern Visual Education," (Messrs. Bausch and Lomb, Rochester, New York).

Erratum.

Page 231, L.H. Column, Line 8, *for* 20 lakhs *read* 2 lakhs.

SUPPLEMENT TO "CURRENT SCIENCE".

Vol. V] November 1936 [No. 5

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Blackpool, 1936.

Mathematical and Physical Sciences.

President: PROF. ALLAN FERGUSON, M.A., D.Sc.

TRENDS IN MODERN PHYSICS.

PROF. ALLAN FERGUSON commenced his Presidential Address to the Section A of the British Association by referring to the losses which Physical Science had suffered during the previous year by the death of McLennan, Glazebrook, Petavel and Pearson. McLennan was a versatile and energetic investigator and director of research, whose contributions ranged from cosmic radiation and spectroscopy to cryogenic work and radium therapy. Glazebrook was a veteran of a previous generation whose fittest monument was the National Physical Laboratory. The work of this great Laboratory was further developed by Petavel, who, though known as an engineer, was also a contributor to Physical Science. Pearson will always be remembered in connection with his development of statistical method and its application to biometrical investigation. His *Grammar of Science* develops a point of view which should not prove unhelpful to the student of to-day who would fain remain a physicist without of necessity becoming a metaphysician.

Turning now to the subject of the address, Prof. Ferguson characterised nineteenth-century science and particularly Victorian Science as showing a simple realism not wholly unrelated to that simple realism of to-day which sees in an α-ray track evidence for the existence of an atom of the same order as that furnished by a diffraction photograph (or, for that matter, of our own eyes) for the existence of a star. The classic outlook was based on the notions of velocity, acceleration, momentum and force which were formed into an ordered scheme by the genius of Newton. The physical science of the eighteenth and nineteenth centuries was occupied in extending and clarifying these concepts, although the formation of a society at Cambridge "to inculcate the principles of pure *d*-ism and to rescue the University from its *dot*-age" was required before the British physical school could rival the advances of their Continental brethren. In spite of these attempts at clarification, fundamentals remained obscure enough: thus mass was the product of volume and density while density could only be defined as mass divided by volume.

The nineteenth century also saw the rise of atomic theories and the many successes of extrapolating the laws which described the motion of planets to the indescribably small atoms. It is an odd fact that in the modern days of probability and indeterminacy we should also see atomic constants determined with greater accuracy than before. However, the British could remember with pride that it was Joule who first evaluated a molecular constant, *viz.*, the mean speed of a Hydrogen molecule at 0 °C. as 6055 ft./sec. in a paper published in 1848. Joule was also responsible, as is well known, for the recognition of the equivalence of heat and energy. Another outstanding feature of the 19th century was that success of the ether theories which led Kelvin to say "This thing we call the luminiferous ether... is the only substance we are confident of in dynamics. One thing we are sure of, and that is the reality and the substantiality of the luminiferous ether." However, the end of the century already saw this conviction totter in the presence of the problem of the distribution of energy amongst the various wavelengths comprising the radiation from a black body. A satisfactory theory could only be given by "quantising" the energy of an oscillator, *i.e.*, by restricting its values to integral multiples of a unit $h\nu$, as was shown by Planck. Another phenomenon which was inexplicable on classical lines but could immediately be explained by means of Quantum Theory was the photoelectric effect. The discrete lines of the spectrum of hydrogen, for example, could only be explained by assuming that electrons were confined to prescribed orbits in which they did not radiate as required by classical theory. The success of this theory of Bohr and its extension by Sommerfeld was large but the more complex spectra required the notion of spin and Pauli's principle before a model capable of explaining them could be found.

In the meanwhile the discovery of the Compton effect emphasised the corpuscular nature of light, while interference, diffraction and polarisation were still explicable only by means of a wave concept. This duality was successfully extended to matter particles by de Broglie who attributed a wavelength h/mv to a particle of mass m and velocity v. This dualism between particles and waves has in recent years been interpreted by correlating the amplitude of the wave at any place with the probability of finding the particle in that position. The particle

conception is still at the bottom of all the attempts made to bombard atoms with fast moving projectiles. To the number of such projectiles there have been notable additions in the form of accelerated protons and, more recently still, fast and slow neutrons. The investigation of cosmic rays has led to the discovery of the positive counterpart of the electron, *viz.*, the positron. In all the nuclear transformations studied, Einstein's law of the equivalence of mass and energy has been amply verified with great accuracy. Very recently, however, the validity of the law of conservation of energy in individual atomic processes has been called in question as a result of experiments on the Compton scattering of γ-rays.[1]

Another remarkable discovery is that of artificial radioactivity. Thus while Rutherford showed in 1919 that on bombarding nitrogen with α-particles we get oxygen and a proton, Curie and Joliot have shown that on bombarding aluminium with α-particles, neutrons are emitted and the remaining isotope of phosphorus is radioactive giving out positrons. Neutron bombardment also produces new radioactive elements which emit positrons or electrons and sometimes γ-rays also and are thus β-active.

The theoretical side has seen the enunciation of the much discussed uncertainty relations, *viz.*, that the product of the errors in two conjugate quantities like energy and time or position and momentum can never be less than the quantum h. It seems however that the word "indeterminism" applied to this principle is based on an extension of the strict meaning of that word. The word "observable" has been similarly treated. The "observable" as understood to-day, such as the frequency of a spectral line, is as far from being a direct percept as an electron-state which is dubbed an "unobservable". It is, therefore, more profitable to develop a canon to serve as a guide through the maze of new perceptual facts by adopting the method discussed in the *Grammar of Science* with some reservations and additions. The term "causality" as discussed by philosophers like Locke, Hume and Mill connoted an unconditional invariability of succession. The trend in physics is to devise a conceptual world of atoms and molecules to assist us in correlating the huge mass of our perceptions to get a simple description. But so long as these concepts do not become objects of perception it is useless to discuss their reality. Thus Planck, who defines an event as causally conditioned if it can be accurately predicted, escapes from a denial of causality on account of the necessarily uncertain character of predictions allowed by Quantum Theory by assuming causality to hold in a conceptual world where accurate predictions are possible. A conceptual world of quantum physics is framed in which a strict determinism reigns. This, however, is not so similar to our conceptual world as one consisting of billiard-ball atoms was. Accordingly the hard-pressed physicist of to-day is on safe ground only so long as he does not confuse the concept with the percept. Further, since Japolsky has developed a theory of the elementary particles on the basis of classical electrodynamics, the solution offered by quantum physics is not final.

Concluding, Prof. Ferguson referred to the remarkable advances made in industrial applications of physics, such as the flotation process for the separation of minerals which depends on a nice application of a knowledge of surface constants such as the angle of contact. He referred also to the observation of the Brownian movement of delicately suspended balances, the study of surface structure by means of electron diffraction, and the progress of low-temperature research. Finally he touched upon the "Impact of Science on Society" and said that a snobbish distinction between cultural and vocational values could not be maintained and the fact must be faced that there are dysgenic applications of science. Therefore the scientist must cease his worship of what Prof. Hogben calls the "Idol of Purity" and must be prepared to discuss all the social implications of his work and to educate himself as well as his less fortunate brethren in a knowledge of these implications.

[1] [Recent work by a number of investigators has shown that the doubt is unfounded.]

Chemistry.

President: PROF. J. C. PHILIP, O.B.E., D.Sc., F.R.S.

THE TRAINING OF THE CHEMIST FOR THE SERVICE OF THE COMMUNITY.

THOSE who may be harrowed by the horrors of civil strife in Spain, the temporary breakdown of the League of Nations and the contemplated possibility of a war to end civilisation, will find in the presidential address of Professor Philip a soothing palliative. Placidly, and at uniform speed we are led through a survey of the services rendered to the community by the chemist, to consideration of the most appropriate professional equipment with which the chemist should be furnished. In fact, the only suggestion of current alarms is a comical picture of popular misconception in regard to chemical research as applied to warfare.

On this point, and on this point only, Professor Philip allows himself some justifiable display of dignified irritation. "The truth is that the employment for other than beneficial ends of substances discovered by the chemist is due, not to his especial wickedness, but to the weakness and backwardness of the human spirit." The truth, having regard to the decorous limits imposed by a presidential address, could scarcely be stated more concisely. He fortifies it by reminding us that the dangerous and poisonous materials produced by chemists arose in the general quest for knowledge, and that many have applications both legitimate and valuable; nitrates and phosgene for example. He could have added that mustard gas, discovered in 1860 by Guthrie, remained a chemical curiosity until July 1917, when it was first used as an offensive agent by the Germans at Ypres: and that chlorine, discovered in 1774 by Scheele, was widely used for bleaching, disinfection and artificial dye-manufacture during decades before the Germans broke their promise, and began the whole disgusting business on April 22, 1915. Actually the pre-War production of chlorine for peaceful purposes in the United States alone averaged 900,000 pounds *per day*.

It is the peaceful purposes to which chemists apply their craft that Professor Philip emphasises, and from the tranquil paragraphs of his address the general reader will gain sorely needed information thereon. He notes with satisfaction the increasing interest shown by the State in the prosecution of these purposes, illustrated by the foundation of the Department of Scientific and Industrial Research followed by the Chemical Research Laboratory at Teddington where, under the skilful direction of Sir Gilbert Morgan during the past ten years, the study of synthetic resins, low-temperature tars, high-pressure reactions, metal-corrosion, chemo-therapy and water softeners, has been pursued by a large staff of trained chemists. Even the State is not yet fully informed on the functions of chemical practitioners, however, and if it can be said to possess knuckles, these are discreetly rapped by Professor Philip with reference to a recent lively wrangle that sprang from the drafting of rules for manufacture of pharmaceutical preparations containing poisons.

The lofty ideal of the medical profession, "serving the community," is quoted as a seemly example for the chemist, and even if this has acquired now-a-days a slightly advertisemental air, it is nevertheless a wholesome slogan. Most chemists who have leisure to extend their analytical habits to their own feelings, however, would probably find that their principal non-profit motive is to serve chemistry; and that if one of the by-products be serving the community, so much the better. Elimination of the profit-motive, especially among servants of the community so notoriously underpaid as chemists, is not so easy; and even Professor Philip himself would seem to be slightly infected with it when, in the next paragraph, he calls for a corporate body to "stand for the common interests of chemists as a whole".

On this question also the address is informative and sound. Tracing the history and purposes of the three large chartered bodies, the Chemical Society, the Institute of Chemistry and the Society of Chemical Industry, and mentioning the numerous ancillary organisations more recently springing from divergent activities, Professor Philip shows how the Chemical Council has arisen, in the ultimate hope of unifying the profession, acquiring adequate premises and establishing a complete register of trained chemists. This rosy prospect has been given seven years—two of which have already passed—for fulfilment, and it is to be greatly hoped that, even if the licensed hours require slight extension, the lions and the lambs will ultimately lie down together. Meanwhile, the Council contents itself with uniting the chemical profession and the chemical industry in support of publications and a central library.

There follows a thoughtful survey of the preparation essential to qualification as a registered chemist, non-pharmaceutical. Its basis must be a broad, general education for character, culture and citizenship, with due regard for accuracy in observation and statement. Professor Philip will have many supporters in regretting the absence of biology from this early stage of training, which he ascribes to the greater facility with which elementary instruction in the physical sciences can be arranged. His urbanity debars him from characterising this omission as laziness, and it is in fact more probably owing to the unfortunate action of London University in changing biology, for the Intermediate Science examination, from a compulsory to an optional subject. This was a real disaster, because even a zoological horizon limited to dissection of the frog, rabbit, dog-fish and earthworm enables you at least to glimpse the theatre of biochemical changes to be studied later, although it is merely a gallery-view.

Professor Philip scents danger at a further stage. Graduates in chemistry "can talk at length about nuclear spins, valency angles, electron sinks, energy levels and so on, but are astonishingly uncertain about more elementary and practical matters". Coming from a physical chemist these words are innocent of bias, and are followed by passages of wisdom relating to co-ordination of knowledge and action in university training; these include a survey of requirements by seekers after training in chemical engineering, which will soon become a degree-subject in the University of London.

Nobody interested in the training of chemists, or, indeed, of science-students in general, should fail to read Professor Philip's address. Besides a plenitude of information and common sense, it offers a refutation of the gibe, unhappily sometimes warranted, that men of science cannot write good English, and in this respect also is an admirable example of an address that is really presidential.

Geology.

President: H. L. HAWKINS, D.Sc., F.G.S.

PALAEONTOLOGY AND HUMANITY.

TO the layman Palæontology is a comparatively unknown science and the work of the Palæontologist is looked upon more with curiosity than conviction. The responsibility for this rests upon the system of education obtaining at the present day and it is the purpose of this address to demonstrate that even Palæontology has a message of vital importance to deliver to mankind.

The object of Palæontological work is to unravel and decipher the records of past life and thus to enable us to adequately appreciate and establish its continuity since early geological times.

Although the time is now past when men in their senses looked upon fossils as freaks of nature, thunderbolts or even ascribed their origin to astrological conjunctions, still old prejudices die hard. But as summed up by Breynius in 1732, a person who would even now deny the true nature of fossils must "assuredly have a fungus for a brain". It was late in the 18th or early 19th century that students of Geognosy, instead of confining themselves to museums and libraries, began to work in the field and to investigate fossils of their own collection. Thus sprang up two sciences and "geology, as we understand it to-day, found in fossils the link that gave continuity to a mass of disconnected observations;" while "Palæontology took its place as the science of the succession of life." The discovery that strata could be correlated and their relative geological ages established is one of the greatest of modern times, for to it we

owe our conception of geological time and the fact of evolution.

There are difficulties that the Palæontologist has to face, difficulties due to the imperfection of the geological record, to the breaks in the stratigraphical succession marked by unconformities and to our own imperfect understanding of the available evidence. There are gaps due to biological factors, for animals and plants without hard parts are completely destroyed.

On account of these limitations the taxonomic divisions proposed by the Palæontologist are bound to be different to those of the Zoologist, who is able to study both the soft and hard parts of the organism. But the biological palæontologist is less concerned with genera and species than with series and trends. In large measure the subdivision into genera and species is tentative. " It gives convenient, but often false, means of expressing morphological qualities. Such familiar ' genera ' as *Gryphæa* and *Exogyra* can be shown to represent stages in the morphogeny of oyster-shells belonging to manifestly different lineages."

By a detailed study of the fossil specimens and the nature of the matrix in which they are embedded, or by comparison with related organisms living to-day, we can deduce the physical conditions relating to climate—temperate, tropical or arid, and environment—marine, freshwater, fluviatile, etc., prevalent at the time of their burial several thousand or even million years ago. It is also known that the survival periods are not the same for the different groups. Some groups are short lived, others have survived throughout the known range of geological time almost since the Cambrian onwards.

It has been fairly established that simplicity of structure combined with efficiency is associated with durability, while specialisation is a sure sign of early decay and possible extinction, for if the environment changes, the organism is unable to adapt itself rapidly enough to changing circumstances. To cite instances, the genus *Cidaris* has persisted with no important modification from the Triassic period to the present day. *Echnocystis* is limited in range to the Upper Silurian. *Heterosalenia* lasted from the Upper Jurassic to the Upper Cretaceous only. Now *Echinocystis* and *Heterosalenia* were both much more elaborate in structures than *Cidaris* so that their short ranges illustrate the generalisation made above. But there are exceptions.

While environment exerts an important influence on the organisms, the major physiographical paroxysyms are often responsible for their decline, but with the decline of one group, the rise of some other group often occurs as an attempt by nature to maintain the equilibrium of life, as it were. Thus the fall of the Nautiloids was compensated by the rise of the Belemnoids, that of the Reptiles was followed by the advance of the Mammals. This may be explained on the ground that the extinction of one group diminishes the intensity of the struggle for existence for the other groups.

An important point bearing upon the evolution of forms is that certain characters, whether their direction was predetermined at the outset, or whether they were induced and selected by circumstances at an early stage, once started, continue to develop in the same direction to a limit that they become a source of weakness and may ultimately be the cause of extermination of the organism that possessed them.

Palæontology affords no evidence at all as to the ultimate origin of various groups or of the manner in which life arose, though we have abundant proof of relationship and descent during the course of geological time. And this at least has been definitely established that the life-history of an individual represents, in an abbreviated form, the life-history of its species, that of the species the history of the genus to which it belongs; the generic history in turn represents the family history in a shorter span.

We now come to the application of palæontological principles to the evolution of man and the human race. One important point must be borne in mind, namely, the brevity of the geological history of man on the globe owing to which very little structural change has come about.

The principal characters that distinguish the human species from others are its upright posture, its capacity for intelligent speech and other mental powers. By the exercise of his intelligence, man is able to overcome difficulties and compensate himself for his structural shortcomings. He can, to a certain extent, overcome the influence of environment, which is an important factor in the evolution of other groups, but bereft of his intelligence, in other respects, he is no better fitted to stand the vicissitudes of environment than an animal.

Now specialisation in one particular direction is a sure sign of decadence and ultimate extermination, and thus high cerebral specialisation points to a rapid and spectacular rise and an equally sudden fall of the human race. But we may look at this from another view-point, that this type of specialisation, on account of its wide scope, its control over environment and over natural destructive forces, is not really specialisation but extreme generalisation and, therefore the human race may yet have a long history before it.

It may therefore be said that paradoxically man "has become supremely generalised by the exercise of a highly specialised faculty."

Palæontological evidence is more reliable than facts of history recorded by men because it is neither influenced by personal outlook, nor tainted with prejudice and deliberately falsified, as human documents sometimes are. A revolution that might have been the salvation of a country according to some may be regarded as a perversion of human capacities by others.

Finally the causes that lead to the decadence of the dominant races and empires are varied. The most important of these are complexity and over-specialisation in one particular direction and internal discord, which results, when the component parts, having struggled together to attain a position of dominance, begin to struggle among themselves, instead of working in harmony. There is then a remarkable correspondence between the behaviour of races and empires and the evolutionary trends of animal groups. Those who deny the truth of the statement surely misread the lines :—

Ill fares the land, to hastening ills a prey,
Where wealth accumulates and men decay.

M. R. SAHNI.

Zoology.

President : J. S. HUXLEY, M.A., D.Sc.

NATURAL SELECTION AND EVOLUTIONARY PROGRESS.

MODERN research in Biology has emphasised above all things the necessaity of synthetic frame of mind to explain evolutionary phenomena. That selection alone or mutation alone cannot produce evolutionary change is the most important outcome of post-War biological thinking and it is becoming increasingly clear that the two processes are neither alternative nor competitive but perfectly complementary. The findings of geneticists have tended to show that the effect of a given gene does not rest within itself but is the outcome of the co-operative action of a number of associated genes, so that we now are concerned with a gene complex. Therefore mutations when they are dominant or recessive, become so through the action of other genes in the gene complex. But the fact remains that most mutations so far investigated are deleterious, and the question will be asked, if mutation is the directive source of change, should it not be advantageous also? That very slight gene differences producing extremely small effects exist has been shown by recent analysis and it is more than likely that these may be the initial factors of evolutionary change. Again, a certain mutation that is harmful in a certain environment may be useful in another as has been shown in the vestigeal winged mutant of *Drosophila* and a few other cases. So that in a Mendelian world, the basis of evolutionary change is a co-operative effort between mutation and natural selection.

It is becoming increasingly clear too that the processes of evolution are very complex involving a number of smaller processes. The origin of species can now no longer be thought the whole of evolution. It is only one of the processes. It is now clear that the origin of new species from pre-existing ones must take place in several different ways. A gradual transformation may bring about the result along two divergent lines. A sudden separation may also occur. Hybridisation is another powerful tool in the hand of Nature resulting in a great complexity of characters which help in species formation. In all these cases physiological as well as geographical isolation is involved. And from the standpoint of natural selection, species will then fall into two contrasted categories. Specific characters which are different from others initially and abruptly could not have been produced by natural selection but in species where character modification is gradual, natural selection must have played an important part in species formation.

The origin of adaptations is another process of evolution. While it is true that one-character, single-step adaptations do exist, generally "most adaptations clearly involve many separate characters" which could not have arisen by mutation alone but which must have been brought about by "some agency which can gradually accumulate and combine a number of contributory changes: and natural selection is the only such agency that we know."

Recently much work has been done to evaluate the importance of the rate of action of genes. "A large number (possibly the majority) of genes exert their effects through the intermediation of a process operating at a definite rate. The speeds of processes with such rate factors control are not absolute, but relative—relative to the speeds of other processes of development and of development in general." The bearing of this on the interpretation of the diverse phenomena of development is considerable and probably the rate of every developmental process is gene-controlled, providing us a clue to the clearer understanding of the evolutionary aspect of recapitulation, neoteny, fœtalisation, clandestine evolution and apparently useless characters.

But natural selection alone has repeatedly produced results as unfavourable as they were unexpected. It is no longer true that natural selection must always be for the good of the species and this is especially so if it is intraspecific and if it is taken to an extreme. The result is often the production of unbalanced organisms whose existence becomes intensely precarious. The result of natural selection is not always progressive improvement; indeed, it is only rarely so. And by no means is it the best mechanism for achieving evolutionary progress.

The process of evolution has been so far one of progress though it has been limited to a few stocks and though it has often resulted in specialisation. In Nature, there is a very thin line between progress and specialisation and while one may lead to further improvement, the other often results in extinction. But what is the general trend of evolution of the future? Man's peculiar way of living and the dawn of conceptual thought in him have made him less susceptible to nature's laws. So that future progress of man must largely rest with man himself. He must formulate for himself a purpose and this purpose must guide the destiny of every individual and the whole race. Many efforts have been made to define this purpose. But what a task?

Geography.

President : BRIGADIER H. S. L. WINTERBOTHEM, C.B., C.M.G., D.S.O.

MAPPING OF THE COLONIAL EMPIRE.

"MAPS are potted information about environment and about man. They are indispensable to us, and at the moment, we are, as regards their production, in the trough and not on the crest."

This is the central theme of Brigadier Winterbothem's presidential address to the section of Geography. Undoubtedly, the first step towards man's comprehension of the physical world around him is its mapping. A chart or a map is not merely a record of the terrain around a given locality, but is also a background against which many details might be depicted.

An outstanding feature of the science of mapping at the present moment is the paucity of maps which give all the information which we have learnt to expect of them. The importance of good maps to administrators can hardly be overrated. It is said that the very backward state of mapping in the United States is due to the fact that the country is rich enough to survive the handicap of indifferent map-making. This warning note must serve as an eye-opener to all, and nations must seriously question themselves

whether they are rich enough to survive a similar handicap. In 1922 in England the order of the day was frugality and building " a land for heroes". Ambitious building programmes were planned, while the survey vote was cut down to the barest minimum. This policy is somewhat akin to the wisdom of an elderly gentleman who, when he has out-grown his old suit of clothes, orders a new one with strict injunctions to the tailor to use a yard less cloth.

Maps are useful not only for what they show, but for what they may be made to show. It is of interest to see in this connection what the British National Survey has done to evolve the modern map.

At first the Geological Survey started an Ordnance Geological Survey and the first 10-mile map was prepared for the River Commissioners, and others were produced at a joint call of archæologists, geologists and soldiers. Population maps helped to delimit inter-state boundaries. Archæological and historical maps emerged as by-products of the mapping of the relevant sites usually as a function of the Ordnance Survey. The position in respect of map-making is not so bad in Great Britain as it is in some of her dependencies. In the areas administered by the Colonial Office, the first step towards seriously attempting the problem of map-making was the establishment of the Depot of Military Knowledge as a branch of the Quarter-Master General's Department. But this department which began with fair promise passed imperceptibly into a state of suspended animation after the defeat of Napolean, and was not revived till the Crimean War. In 1855 the idea, that a department of Geography should be attached permanently to the Foreign Office, originated by a certain Major Jervis, took effect and a " Topographical and Statistical " department was founded. For some time, this department and the Ordnance Survey (essentially a domestic survey) were coalesced under a single director, but financial stress cut them asunder; the topographical department concerning itself with the especial task of overseas and colonial map-making. The first map produced by this section was that of Africa, compiled from a miscellaneous horde of data that had accumulated by random collection. Another large and important series produced under the same auspices, was that of Asia Minor which was still the best map extant of that region at the beginning of the War. Since the War the Geographical Section has produced two very important series of maps, *viz.*, the $\frac{1}{4}$-M of Asia and the $\frac{1}{4}$-M of Africa which are remarkable alike for accuracy and painstaking execution.

To-day the most important factor in map-making is reliable ground survey. Surveying, in general, consists of two branches, *viz.*, property survey and topographical survey. Property survey is the concern of private practitioners, who carry them out for their clients; while topographical survey is conducted for the State by soldiers. In Africa the property surveyor was the first to be active and his activities date back to the early Dutch settlements at the Cape. British colonial development owes a lasting debt to the pioneer Royal Engineers who made possible the construction of roads and railways and cathedrals and government houses not to speak of the towns themselves.

A step forward towards the fusion of the property and topographical surveys was taken when the astronomer entered the field. It was due to Sir David Gill that the triangulation of the Union of South Africa was initiated and completed, and it was his ambition to see that it was carried through till it joined the Egyptian triangulation completing an arc roughly along the 30° E. meridian of Greenwich.

The War period saw the complete cessation of all mapping and revision in Great Britain. But in Africa this was by no means the case. A good deal of East Africa was learnt, and improvement and compilation of the more generalised maps were seen through on account of dire necessity. Since the War, however, there has been little progress compared to what was achieved during the previous period. Land surveying did record some improvement and triangulation was steadily carried on by Mudge in England and Everest in India. The next important step in the advance of colonial survey was to build up a department which is both economical to run and is graded into specialised branches. This was of the utmost importance to Africa as both money and labour were being expended uneconomically. As a result of the recommendations of General Hills, Sir Gordon Guggisberg began to introduce a progressively increasing native element into the survey department of Nigeria and the Gold Coast. Gradually this practice which had its precedent in India is gaining ground in the other British Colonies.

An important addition to the surveyors equipment in modern times is the advent of aerial surveying which has made considerable contributions to his bill of fare. As a method this is without rival as it is invaluable to the surveyor while surveying inaccessible ground.

Despite the rapid advances which surveying in all its phases has registered, topographical mapping in the colonies is showing signs of decay and compared to the pre-War record the post-War achievements present a melancholy contrast. For instance, there is a certain British West Indian Island which is " insisting on remaining unmapped " and thereby saddling the fruit industry with an extra annual expenditure of a thousand pounds. Again in many of the boundary demarcation expeditions local officials are being increasingly employed instead of imperial parties and so we have failed to secure proper boundary mappings.

The most serious problem for the future in colonial mapping, is the overhauling of the machinery as a whole. It must not be concluded, however, that the Geographical Section is idle to-day. It has inaugurated periodical conferences of empire surveyors, and has started the *Empire Survey Review* which can be ranked as the best of its kind in the world; and the surveyors themselves have co-ordinated the various aspects of their work. But it is " the trust in the higher beings which has failed". The fault mainly rests with the fact that public opinion in England is slow to grasp the real situation in Africa and the position is worsened as there are few good maps on which the public can work. Past experience has taught that social, economic or industrial development cannot be divorced from land surveying and it is the urgent necessity of the day for geographers to forward this matter, in the interest of colonial development.

Engineering.

President: PROF. WILLIAM CRAMP, D.Sc., M.I.E.E.

THE ENGINEER AND THE NATION.

"THE object of the British Association is to make known, as widely as possible not only the aims and achievements of every science, but also the bearing of each advance upon world conditions. The very fact that engineering was the seventh section to be formed shows that there never was any intention to restrict the activities of the Association to 'pure' as distinct from 'applied' science. Our President was strictly in order when he suggested, last January, that Sectional Presidents should not hesitate to deal with current difficulties and misconceptions in their particular fields of work, and with the reactions of that work upon the community. These are matters that concern the engineer very closely, since his activity is linked with the national life and often consists in the application of knowledge previously secured by the physicist, chemist and metallurgist. He himself is not thereby debarred from fundamental researches. On the contrary, he is frequently led to investigate in detail problems half solved by the physicist, or to discover phenomena which the chemist has missed. No better example could be quoted than the arc-rectifier which from its humble beginning in the investigations of Cooper-Hewitt to its present position as the most important converter in heavy electrical engineering is entirely the work of engineers."

PURE SCIENCE AND ENGINEERING.

"But though engineering has for so many years been regarded as a branch of science by the British Association, there are great and fundamental differences between those engaged in pure science and the engineers. The former may, if they so choose, indulge in a life of ardent detached curiosity, devoting themselves to the observation of behaviour and to the construction of a framework of principles neatly fitting the collected observations. To such men, the known is just a key to the unknown, and the unknown is the one thing worth knowing. This is called the pursuit of truth as distinct from the pursuit of learning."

The function of the engineer is to supply the co-ordinated knowledge of the pure scientist and the experience of the ages to the satisfaction of human desire, and to the increase of the amenities of life. He is the link between human experience and scientific knowledge, and, as such, he cannot perpetually live in a rarefied atmosphere of detachment. He must be in daily contact with humanity and learn to understand human psychology as well as human needs. As a result, he is less specialised, more balanced, more adaptable and understanding than his colleague in pure science. His judgment in human affairs is more developed; he is a better 'mixer'. A nation of pure investigators would be calm and peaceful, but cold as Scotland Yard. A nation of engineers might be quite a pleasant community.

ENGINEERING AND CIVILISATION.

In its purest form, engineering is the greatest instrument of civilisation that the world has ever seen, in the sense that it continually tends to promote a closer contact, a greater intimacy, and therefore a more profound understanding between individuals and nations. Three-fourths of the work of the engineer is devoted to the development of communication. Roads, canals, bridges, railways, harbours, ships, motorcars, aeroplanes, telegraphs, telephones, television, all these and many more are humanity's hypens. Their natural effect is to foster friendliness and dissolve differences. Left undisturbed by the politician, the scaremonger, and the patriot, the engineer would demolish the Tower of Babel and render war impossible. Build a channel tunnel; then Calais and Dover become neighbours and Anglo-French understanding ensues in all senses. Place transmitters in the trenches with receivers and televisors at home; then war becomes unthinkable. The very first thing that a government does on going to war is to seize and control every means of communication and every engineering device that might otherwise serve to unite the combatants. For the promotion of peace and understanding, engineering easily outclasses every religion; and for battle, murder, and sudden death it has no equal.

STATUS OF THE ENGINEER.

At all times, in peace or in war, the engineer must be intimately concerned with human relationships. This fact gives him proportionately greater opportunities both for the development and for the loss of character: his chances of salvation and of damnation are alike increased. For character does not mature in cloisters and exposure is necessary to prove immunity. To what extent do his fellow subjects recognise this national importance and this difficult dual rôle; and to what extent does the engineer abuse his unique position or allow himself to be made the tool of less scrupulous men?

The engineer now has the liability without the status. The doctor or barrister has fairly acquired the status; but the organisation to which he belongs tends, as I think unwisely, to shield him from the healthy breeze of liability.

REMUNERATION OF THE ENGINEER.

The contrast between the remuneration of the engineer and that of the other professions is very striking. The doctor or the barrister at equal ages gets very much more than an engineer. Consequently, the output of original work from the medical schools is small compared with other branches of pure and applied science.

CHARGES AGAINST THE ENGINEER.

The first is that he is equally willing to lend himself to works of utility and to works of death and destruction. Remember, however, his dual rôle. Pure science has nothing to do with ethics, she recognises no moral obligations whatsoever. The same explosive that releases coal underground can also kill men in battle. The telephone is useful alike in the home and in the front line trenches. The same bacteria may be beneficial in one case, harmful in another. The same principles that bring the stars within our ken also control the range-finder. There is no scientific apparatus that cannot be misapplied; and to every advantage there is a corresponding drawback. The ear that relishes music is the more sensitive to discordant noise. Not until beauty is seen to be beautiful can ugliness be defined. To the extent that the engineer is a scientist, the use to which his discoveries shall be put

does not concern him. But, it will be urged, the engineer on the human and commercial side designs to make armaments for profit. And if he does, he should be credited with at least as much honesty of purpose as the politician who declares war and orders the guns.

The engineer is charged with the creation of the problem of unemployment by his inventions, such as, the internal combustion engine and various labour-saving devices. But to rid the world of machines needs a change of attitude towards occupation, a love of monotonous work for its own sake, a real desire for real work and not merely for the reward thereof. These, however, seem difficult.

Another charge against the engineer is that they are not fertile or enterprising, nor introduce new industries in distressed areas. But the law of patents right is such that it does not afford real protection to the inventor. To defend a patent or to attack an alleged infringement involves incredible legal expense, and large firms knowing this, will unblushingly copy the invention relying on the inability of the patentee to finance an attack.

Anthropology.

President: MISS D. A. E. GARROD.

THE UPPER PALAEOLITHIC IN THE LIGHT OF RECENT DISCOVERY.

PREHISTORIC studies have received a new impetus during the last 12 years by the multiplication of researches outside Europe. Excavations outside Europe have shown the possibility of a revision of the existing knowledge about the palæolithic cultures. Three important cultural elements of primary importance in the Old Stone Age are manifested in the so-called hand axe industries, flake industries and blade industries. The first two run side by side as far back as can be seen, but the origins of the third may have to be sought much further back. Any attempt to present in an intelligible form the vision of man's earliest history is hampered by a vocabulary which is out of date. The terms Lower, Middle and Upper Palæolithic are used at the same time in a chronological and a typological sense. Miss Garrod however believes that the time has come when the labels Lower, Middle and Upper Palæolithic should be used exclusively in a chronological sense without any typographical connotation to cover approximately the periods from the beginning of the Pleistocene to the end of the Riss Glacial, from the end of the Riss to the middle of the Würm, from the middle of the Würm to the close of the Pleistocene respectively. For purposes of typological classification the three main groups of hand axe, flake and blade cultures are essential and it will be necessary to multiply names derived from type stations to denote the many varieties found within these groups.

The blade cultures of the Upper Palæolithic must have passed through the early stages of their development somewhere outside Europe during Middle or even Lower Palæolithic times though as Miss Garrod admits there exists only the faintest clue as to how and when that development took place. She discusses the type stations in Europe, Asia and Africa and shows clearly the diversity of the strains grouped so far together under the name Aurignacian and also how the blade industries developed their main characteristics at a surprisingly early date.

Perigord, a classic centre for prehistoric studies, indicates a close relationship between the Lower and Upper stages of the Aurignacian. Laugerie Haute finds resemble the industry of Ros del Ser in the Correze and the Upper Chatelperron level. Discoveries of remarkable parietal engravings in pure Aurignacian style in the caves of La Hoz and Las Casares in the province of Guadulaja and the excavations of Senor Pircot Garcia in the cave of Parpallo show that the commonly accepted view that Spain was a Capsian province needs to be modified. The Franco-Cantabric cultures appear to be intrusive in the southern part of the Peninsula and a parallel development from a more or less typical early Aurignacian to a rather finely characterised late industry is probable. Capsian influences appear in the final stages which agree with the late dating of the Capsian as proposed by Vaufrey. Recent study of the Italian blade industries by Vaufrey has shown that they present a single facies corresponding in time with the whole period of the Aurignacian, Solutrean and Magdalenian in France. In the south Russian plain, a probable succession of blade industries has been worked out though this is not yet confirmed at all points by stratigraphical evidence. Typologically the sites discovered fall into two divisions, the first characterised by an industry of Willendorf type and the second by a rather generalised Upper Aurignacian. In Southern Siberia has been found a most remarkable series of objects in bone and ivory and female statuettes carved in bone belonging probably to the Gagarine family. The mixture of Mousterian and Aurignacian forms in the lithic industry is a fact which suggests possible connection with the Far East as the discovery of a similar industry in the lœss along the course, of the Shuitungkou River in Northern China indicates.

The discovery of a highly developed Aurignacian of Willendorf type in the Palæolithic of Southern Kurdistan suggests a connection with the Kostenski I, the earliest known blade industry of South Russia. Excavations in Palestine have established a sequence of blade cultures. Egypt was cut off from the main lines of development in Upper Palæolithic times since blade industries proper are unknown before the appearance of the microlithic cultures. In Africa which still awaits systematic excavation, investigations point to the possibility of true blade cultures arriving late, their place taken up by Aterian with strong Mousterian traditions. The Microlithic facies appeared in Africa perhaps much earlier than in Europe, though it is difficult to maintain this in view of the paucity of evidence. There is no proof, however, that the Kenya Aurignacian is older than the Eurasiatic blade industries and Miss Garrod points out that the late survival of a culture of Mousterian tradition as in Little Africa and Egypt, in the cases of the Kenya Stillbay is certain.

The blade cultures have a wide distribution and it is unlikely that the key to the progress is to be found in Southern France. The French sequence appears to be the result of successive immigrations superimposed perhaps on a certain amount of local variations and development in place. The first blade industry to reach Western

Europe is that of the Chatelperron stage. The Lower Kenya Aurignacian appears to be more or less of Chatelperron type and may be contemporary with this stage in France. A similar, though not identical industry, occurs at the base of the Upper Palæolithic sequence in Palestine. Thus at the beginning of the Upper Palæolithic three areas with similar industries are found. Two of these, Palestine and East Africa, may have been in touch with each other through Arabia and across the Bab-el Mandeb while the third remains apparently isolated.

The Chatelperronian may have developed from the contact of the Acheulean and Levalloisian cultures but it is more probable that Chatelperron had an independent existence, and having developed in some centre still unknown it is an intrusive element in the Acheulean. The original home of Chatelperron industry cannot be Palestine or East Africa but an Asiatic centre seems inevitable. East Africa may possibly be the centre of origin of the Capsian which would thus enter Little Africa by way of the Sahara. The Capsian would thus derive many of its features direct from the Chatelperronian. As for the peculiar industry which closes the Upper Palæolithic sequence in Palestine it is quite definitely Aurignacian rather than Capsian.

The Aurignacian and Chatelperronian appear to have developed independently from an early date. The Gravette-Font-Robert industry has a very wide distribution in Central and Eastern Europe and its remarkable development in this region points rather to a Euro-Asiatic origin. The Capsian and the Gravette-Font-Robert industry are perhaps derived from the Chatelperronian. Though the Gravettian industry appears to be of eastern origin yet Central Europe cannot be regarded as the centre of dispersion as there is clear evidence that the Gravettian is there preceded by the Aurignacian proper. Nor is it likely that the centre of dispersion can lie very much further to the east. In Palestine the true Gravettian is absent and in Southern Kurdistan it probably represents a relatively late migration from Russia. In Palestine the Chatelperronian level shows signs of evolution towards the Gravettian type and it is possible that an industry of this character had already penetrated into Northeast Europe before the westward moving Aurignacian invasion had reached the Mediterranean coast. Thus the Chatelperronian has emerged in the Lower Palæolithic and sent out two branches, one into East Africa to give rise to the Capsian, the other into Northeast Europe to develop into the Gravettian. The Aurignacian pushes westward in the meanwhile and separates these into two great provinces. From Aurignacian and Gravettian centres migrations poured into Central and Eastern Europe and interpenetrations took place along the fringes of the original provinces.

DIRENDRA NATH MAJUMDAR.

Physiology.

President: PROF. R. J. S. MCDOWALL, M.D., D.Sc., F.R.C.P.

THE CONTROL OF THE CIRCULATION OF THE BLOOD.

IN his Presidential Address, Prof. R. J. S. McDowall has given an account of the various mechanisms which work together to provide adequate blood supply to any part of the body whatever its activity or whatever the posture of the body. He has dealt with the effects of physical exercise since most of the mechanisms elaborated in his address are brought into operation thereby. Thus when a tissue, *e.g.*, muscle, increases its activity it needs more blood per minute to ensure a proper supply of oxygen and food. This is brought about by variations not only in the activity of the heart but also by a redistribution of blood. The heart can, within limits, increase its output and alter its rate. The heart is under the control of the sympathetic and vagus nerves or rather under the control of two sets of reflexes. In the case of the sympathetic, the source of afferent impulse is not accurately known, but in the case of inhibitory impulses, the source of afferent impulses is known to be situated " in the left side of the heart, arch of the aorta and the carotid sinuses " and the normal method of stimulation has been shewn to be the change of blood pressure in these parts of the circulation at each beat of the heart.

During the exercise there is an increase in the sympathetic accelerator and reduction in vagus impulses. The range of acceleration is determined by the degree of activity of cardio-inhibitory centre. In athletes mild exercise results in an increased cardiac output with a slight increase in rate. Animals and human beings taking large amounts of exercise have slow hearts and the cause for the slow heart is not known. The increase in cardiac output is the result of dilatation of the vessels in active muscles, and the constriction of vessels in less active tissues. The dilatation is due to chemical and nervous influences. The cause for the chemical dilatation has been much debated. Carbon dioxide and lactic acid, changes in H-ion concentration, adenylic acid, histamine and histamine-like substances are credited with a vasodilator function. The nervous dilatation is probably sympathetic.

In describing the " capacity effects " Prof. McDowall states that with the possible exception of the voluntary muscles, the heart muscle and the brain, all the other tissues of the body provide the blood necessary for the active muscles. He refers also to the constriction of the spleen and intestine in animals, and to the constriction of vessels of the skin under emotional stress or anticipated activity. The sympathetic constriction of the vessels is due perhaps to a sensory stimulation from the outside world.

The maintenance of vascular reserve is rendered possible by the existence of the tonic dilator control of the vessels. The primary function of the control of vessels is to maintain the arterial pressure at a constant level. The reflex control may have a more important function, and in exercise or emotion increase both rate of the heart and output per beat. It may be stated that the vagus controls the range of activity of the heart and the depressor reflexes determine the quantity of blood available for the heart. The vaso-constrictor action of the sympathetic and the effect of adrenaline and the value of the other mechanisms are already referred to. Adrenaline in physiological doses constricts the vessels of the skin and splanchnic region but dilates those of the muscles which latter is perhaps due to its environment. Further adrenaline influences the depressor reflexes markedly, as it has been

found that after the effects of injection of adrenaline have passed off, vagus stimulation, effective before injection, has no action on the heart; similarly in injection of adrenaline the effects of blocking of impulses from the carotid sinus are either reduced or completely abolished.

A study of the effect of exercise and of emotion on man affords confirmative evidence of the function of the vasodilator reflexes mentioned earlier in the address. A rise in systolic blood pressure of man taking exercise on a stationary cycle, with subsequent fall below normal on the cessation of exercise, has been observed. The fall in pressure is due in part at least to a diminution of the peripheral resistance in the muscle. It has also been observed there is no change in blood pressure as a result of psychical effect of intended exercise and that of exercise and the rise in arterial pressure is therefore due to psychical effect. Since it is known from the work of Mosso, Barcroft, Florey and Florey that generalised vaso-constriction is an accompaniment of psychical effect " we must assume that the increased output of the heart is in part if not wholly the result of vaso-constriction which calls into use the reserves of blood and thus circulation is maintained in spite of the greatly increased capacity of the active muscles". It should be observed that the problem of the control of circulation of the blood is bristling with difficulties, especially since the activity of the vagus and depressor mechanisms is variable in different animals under varying experimental conditions.

A. S. R.

Psychology.

President : DR. A. W. WOLTERS.

THE PATTERNS OF EXPERIENCE.

THE Presidential Address is devoted to recording of certain reflections stimulated by contributions to the Psychology section of the previous year's session, and to a short active vindication of some of the views of the colleagues of the President. A comparatively young discipline like Psychology which has not yet acquired any great content of established fact is bound to be confronted with controversies and civil wars which need not be deplored. Controversy is the vital breath of science. A too ready loyalty to "a school" is symptomatic of a fettered mentality. Omniscience or infallibility cannot be claimed for this or that group of workers and researchers however distinguished. Opposing theories have in them elements of truth. A balanced and judicious eclecticism is thus not only reasonable but inevitable. Eclecticism *qua* cheap collection of elements from different schools or groups is valueless unless the dynamic orientation is administered to it of a personal view-point. Two papers read last year are taken as texts.

Prof. Rubin's paper on the "Ways of Seeing" makes an important contribution to the psychology of perception maintaining the thesis that perceptual cognition or awareness is shot through with suggestions of movement and direction which are not reducible to the geometry of the object. The mind contributes structural principles to its own experience. This had been emphasised before by others, but, the value of Rubin's contribution lay in experimental elaboration and demonstration of the theme. Rubin pointed out that pictures in European Art have a definite left-to-right character on which their meaning and æsthetic appeal largely depend. An exciting confirmation of Rubin's theory was afforded in the shape of a drawing of Rembrandt which proved to be an exception to Rubin's general thesis. Rembrandt's error explained by Mr. Betts as due to absorption in technique of sketch, really confirms Rubin's conclusion. This is something like *exceptio probat regulam.*

There are then, pre-established manners of seeing, and it must follow that other modalities of sense also reveal pre-established manners. The patterns of perceptual experience are dependent upon the mind, in some instances upon congenital endowment and in others upon acquired factors. Rubin suggested that the left-to-right direction of European pictures was derived from reading left-to-right script. Mr. Peake suggested that Rubin's theory may be tested in reference to cave-drawings. This is yet to be done. So far as the evidence now available goes, right-handedness is among the determinants of perceptual direction. It appears that perception can be shaped by factors extrinsic to the material experienced. The mind influenced by them is creating, is actively patterning its experience, so that in some sense and to some degree, (the limits being experimentally ascertainable) the mind makes the world it knows. If, on a view like this, no knowledge is possible of reality, as some would contend, the other contention is equally forceful that if the percipient mind merely registered the objective world there could be no psychology of perception worth the name. The researches of Katz and Thouless demonstrate that the mind sometimes deals with its material autocratically. Here Gestalt-psychology cannot be treated incidentally but admiration for the ingenious research stimulated by it cannot be witheld. To speak a little dogmatically the mind informs its sensory material making the percept consistent with certain subjective principles. The patterns of experience are latent in some sense, in the subject's mind as he confronts the world.

Perceiving is a response of the organism. It means that the distinction between cognition and conation is not ultimate. *Conation must* be fundamental because every organism must remain alive and to that end it needs to shape, and control its environment. Behaviour exhibits ordered sequence on the basis of which laws are formulated. A man's business activities show a constant pattern. Patterns are the constancies without which social life would be impossible. Instincts are examples of behaviour-patterns. These patterns are observable in virtue of which the epithet 'instinctive' is used. The character of the organism is among the causes that produce the patterns. Human behaviour patterns resemble those of animals. A pattern is latent in the organism. It exists formally. There are also patterns in acquired activities. Skill is said to produce the patterns. Skill in itself cannot be scientifically inspected but the resultant activity can. Skill is responsible for characteristic behaviour-patterns which control

environment and which lead a subject from success to success as it were. Skill is conditioned by racial and individual experience. Perception is a preparatory reaction and Rubin's 'ways of seeing' belong to the vast family of skills. It was argued in a paper read at a London Meeting (1931) that concepts are not mental entities but as outline preparations for response. Conceptual thinking is schematic preparation for response. Prof. Bartlett uses the term 'schema' for active organisation of past reactions with which new experiences are redintegrated. Characteristically redintegrated effect of experience determines responses of the subject at all moments. Racial and individual experience results in schematic preparation for future activity thereby determining the pattern of the experiencing and the pattern experienced, and these preparations or schemata are modifications of the psychological organism.

This view is illustrated in reference to social psychology and social patterns. Reference is made to Prof. T. North Whitehead's paper in which report is made of a study of a group of five girls at the same task. They had developed a social pattern on the basis of conversation, and when their seating arrangement was deliberately altered output was adversely affected. Other details of the experiment are given which demonstrate that the developments of social patterns is due to the psychological character of individuals. A group or society exists only in virtue of the conative tendencies developed by individuals. It requires to live socially, considerable skill. Social skills are schematic preparations for adaptive responses. Society exists immanently in the minds of its members. A group pattern is the product of the behaviour schemata of the constituent members. Social patterns are exemplified in institutions and current ideas—the English Common Law for instance. There is no need ' to turn round upon the schemata ' so long as particular patterns contribute to efficient life.

Ideals and institutions express the developing patterns of society. An Ideal is just a scheme of behaviour rendered sufficiently inspectable to receive a name. The activities of the organism striving to hold its own in the universe would form the subject-matter of Psychology. The material presented to it in experience should be organised into patterns if it is to control its environment. It develops skills. These skills are called schemata. The system of a person's schemata embodies all his experience upto the present and determines the direction of his future behaviour. The patterns are formed by them though not independently of objective conditions. "Ways of seeing" and "ways of living" would then be species of a common psychological genus. Thus in conclusion experience in the fullest sense of the term is formed in a complex of patterns interlacing and revealing a heirarchy of increasing generality. Or Psychology is a study of all the detailed embroideries upon behaviour patterns the formula of which runs—He was born, strove to master his world for his own safety; he mated, fought for his offspring and died. There is really no opposition between Individual Psychology and Social Psychology.

R. NAGA RAJA SARMA.

Botany.

President: J. RAMSBOTTOM, O.B.E.

THE USES OF FUNGI.

(1) *Edible Fungi.*—The common edible mushrooms are probably the best known of all the fungi and they are cultivated on a large scale in Europe and America. Formerly it was believed that they occurred spontaneously on horse dung. Nowadays the spawn is produced commercially by scientific methods by inoculation with either the spores of the fungus or the flesh of the stipe. The annual production of mushrooms in America now exceeds 17,000,000 lb.

The Japanese and the Chinese are great consumers of fungi. Several species of *Cortinellus* are cultivated widely in Japan for the purpose. About £100,000 worth of the material is exported annually from Japan. "Kah-peh-soon", which is much valued as food by the Chinese in Formosa is the hypertrophied portion of the shoot of *Zizania aquatica* infected with *Ustilago esculenta*. Species of edible *Volvaria* are also cultivated in the tropics. The highly esteemed truffles and morels of Europe and America are fungi belonging to the family *Tuberaceæ*.

(2) *Poisonous Fungi.*—It is also well known that some of the common fungi are poisonous. The French criminal, Girard, who was executed in 1918, used *Amanita phalloides* for poisoning his victims. In the religious rites of certain Siberian tribes *Amanita* is used for its intoxicating effects. It is reported that the Watusi tribes of Victoria Nyanza, for acts of vengeance, used to remove the lungs of persons who had recently died of pneumomycosis, dried and powdered them and administered this powder in banana beer. The fungus always survives the treatment.

(3) *Articles of Toilet.*—Hottentot ladies use the spores of *Podaxis carcinomalis*, as a face powder. The black spores of *Ustilago esculenta* are used in Japan for blackening the eye-brows. Spores of *Tolyposporium* were found mixed with rice flour as face powder in the "vanity case" of "An European Mummy" from a Roman cemetery near Budapest.

(4) *Ornamentation of Wood Work.*—The famous green wood of Tunbridge ware is only oak or birch containing the mycelium of *Chlorosplenium æruginosum* which imparts the green colour to wood. The black lines of some decorative wood are due to infection by *Armillaria mellea* or *Ustilina vulgaris*. The colour of the much valued "brown oak" is due to infection with *Fistulina hepatica*.

(5) *Fodder for the Cattle.*—On the Chiloe Island and in Eastern Patagonia the wood of various trees is converted into palatable fodder by the action of *Mucor racemosus* in conjunction with bacteria. Inoculation with *Aspergillus fumigatus* raises the assimilable protein content of straw.

(6) *Medicinal.*—The ergot of rye (*Claviceps purpurea*) is mentioned in the British Pharmacopœa. The medicinal properties of Agarics like *Polyporus officinalis* have been recorded by classical writers. Yeast is still used for various ailments and is incorporated in many patent medicines. *Cordyceps sinensis* which parasitises the caterpillar is widely used as medicine by the natives of China and Tibet.

(7) *Horticultural.*—The part played by the mycorrhiza of fungi in the cultivation of orchids is

now well known to horticulturists. The difficulty in germinating the minute orchid seeds had baffled the horticulturists for a very long time. Noel Bernard however astounded the botanical world by extracting a fungus from the roots of *Neottia* (the bird nest orchid) and by sowing the seed with it obtained abundant germination. This method is now used commercially. Like the orchids many of the forest trees have fungal mycorrhiza in their roots which help the passage of food into the tree roots. Sylviculturists are now investigating the problem of artificially infecting seedlings with appropriate fungi.

(8) *Food and Drinks.*—The use of fungi in bringing about desirable changes in food and drink has been known from very early times. At present this is done under controlled conditions and fungi are becoming increasingly important in the industrial application of fermentation activities. "The chemical conversions performed by these organisms rather resemble witchcraft than chemistry." In bread-making the use of leaven which contains the yeast is very well known. Nowadays pure culture strains of compressed yeast are used in bread-making.

Yeasts bring about the fermentation of fruit juices in the manufacture of cider and wines. *Botrytis cinerea* is used for infecting grapes to produce the Sauterne wines with higher alcohol contents. Beer brewing is now a well-known art. Almost every nation has its ancient fermented drink like the Kvass of Russia and a few others.

Certain bacteria are also used in conjunction with yeast for bringing about fermentation in beverages like the Mexican Tibi. Chinese curd, To-fu, is made from soybean milk fermented with mould. Food products and beverages amounting to a value of £40,000,000 are manufactured annually in Japan alone by the fermentation activities of fungi. The Chinese "Red rice" is produced by infection with *Monascus purpureus*. The part played by species of *Penicillium* in the ripening and flavouring of cheese is only too well known.

(9) *Fuel.*—In order to economise the use of coal, the supply of which is not likely to last very long, power alcohol obtained from plant materials by fermentation with yeast may have to be substituted.

(10) *Industrial.*—The production of dextro and lævo tartaric acid by Pasteur by the action of *Penicillium glaucum* is probably the first step in the use of fungi to industry. Van Tieghan isolated gallic acid from tannin by fermentation with *Aspergillus niger*. During the War, glycerine for nitroglycerine, was manufactured first by the Germans and then by the Americans by the fermentation of sugar with yeast. Commercial diastase is manufactured from *Aspergillus flavus-Oryzæ*. Oxalic and citric acids are produced as a result of fermentation by many fungi. An American firm is stated to maintain nine acres of mycelium of *Aspergillus niger* to supply calcium citrate for the American cheese industry. Gluconic acid is another fermentation product of *A. niger* and several species of *Penicillium*. Anthroquinone pigments which are so important in dyeing are produced by certain species of *Helminthosporium*. The antispetic, penicillin, is produced from *Penicillium notatum* and *Fusarium* sp. produce large quantities of alcohol from glucose. Ergosterol has been synthesised by the action of yeasts and moulds. Marmite is an extract prepared by autolysis from fresh brewers' yeast. The Russians after the War utilised yeast for the production of fat. The manufacture of acetone with *Mucor Roxii* is one of the romances of modern microbiology.

The above are only just a few of the products obtained with the help of fungi. A vast field for useful researches is thus opened out where the taxonomist, chemist and physiologist can work profitably together for the good of humanity.

K. C. M.

Educational Science.

President : SIR RICHARD LIVINGSTONE, M.A., HON.D.LITT., HON.LL.D.

THE FUTURE OF EDUCATION.

"To cease education at 14 is as unnatural as to die at 14. The one is physical, the other is intellectual death."

THIS is the main thesis of the address which expounds the need for a strong and efficient system of continuation and adult schools for the diffusion of the essential elements of culture in order to equip the democracy in the intelligent participation of public problems and in the maintenance of a reasonably high standard of useful and enlightened life. So far as education is concerned the primary duty of the State is to provide for every individual opportunities to make a livelihood and to function as a citizen and to become the " beauty of the world". In endeavouring to achieve these three-fold objects, education is obviously limited by its material, and encounters difficulties in the accomplishment of its goal of the making of human beings. If this is the supreme aim of education, then it follows that all men and women, irrespective of the class to which they belong, must have a cultural training without prejudice to the technical courses which the majority may find it profitable to pursue. Men differ in degree but not in kind, and if the electorate is incapable of appreciating the great historical movements or the wealth and variety of the human spirit, then its stability becomes precarious, and its political and spiritual life, impoverished. Perhaps humanistic studies might preserve the democracy from such a disaster.

Education in its different branches,—University, Secondary, Technical and Elementary,—has solved some of the problems with which it was confronted, but we have not been able yet to define to our own mind what we wish education to do for us, and to ask whether it is doing it and, if not, why not. The examination papers reveal the great gaps in our national system of education and the task of improvement and elaboration necessary for the more efficient use of its tools for obtaining a deeper insight into its purpose and significance. There is a fairly satisfactory provision for the minority who attend secondary school and university, but we have shown the rest either a glimpse of the vast treasures of knowledge or disinherited them from the purest and highest intellectual pleasures. The question of the working-man and his leisure affects the future of civilisation. Will he enrich it ? or will he devote his leisure to the films and the dog races ? Fifty years ago the employment of leisure was no problem for any but the rich

who mostly wasted it, but to-day it is becoming a common place of education. The task of the future is for us to ask ourselves how the intellectual and spiritual life of the nation will fare, when the greater part of its people leave school at the age of 14 and are thrown straight into the deeper waters of life. In this matter the attitude of the State has been as complacent and unthinking, if not as disastrous and cruel, as that of the earlier generation who acquisced in social inequalities which seem incredible to us. The task of the future is clear, *viz.*, to deal with this great educational problem of the boys and girls who leave school at 14.

One of the fundamental principles of education is that its fruitfulness depends on experience of life, though this may not apply to the physical sciences with the same force as it does to the humanistic subjects. It is necessary to know life itself, to have seen something of human nature, before either achievement or understanding in these fields is possible, and it is obvious that a fourteen or fifteen-year-old is not sufficiently adult to grasp the value and significance of history, economics, sociology, politics and philosophy. What does a pupil of the age of 14, 15, 16, 17 get from the study of history, for instance which in secondary schools is a favourite subject for specialisation? They are well taught and interested in the subject and they can reproduce the best books. " They have the appearance of wisdom but not its reality " as Plato said of these who absorb information from books without digesting it.

The practical conclusion is that an education which ends at the age of 14 is no education at all. Money spent on secondary education is not wasted if it prepares the pupil to go on to something else. The fact is that a vast majority go to nothing else, after putting their feet on the first step of the ladder of knowledge. But the defects of the present system will not be remedied by raising the school age to 15 or even to 16. The pupil will be still unripe for the studies without which an intelligent democracy cannot be created. Raising the school-leaving age may help some of our difficulties. Its value is perhaps moral and economic rather than intellectual. No body who has seen the results of compulsory education to the age of 16 in the U.S.A. will be under the delusion that it produces an educated nation. If, however, the raising of the school-leaving age is preparatory to an education continued into the adult years, well and good; if not it will leave the problem still unsolved.

The solution of this problem will not be found in the secondary education about which this age is over-credulous. The hard fight for its development has caused us to exaggerate what it can do. Secondary education is only one part of the great picture; and we need to stand back a little and see the canvas as a whole. Economic reasons suggest that the earlier years of life should be given to secondary education which is addressed to pupils whose intellectual faculty, except that of memory and imagination, is not fully developed, and who cannot have a full perception of the purpose and value of education. In every point except the economic one adult education has the advantage over secondary education. It is given to students who desire it, and who have the mental development to receive it; whereas secondary education is given to pupils whose faculties are not fully developed, and who have not seen enough of life to value and interpret it. It should be realised that the education of the masses can never be achieved through secondary education. The ideal plan might be for everyone to leave school at 15, and pass into a system where a part of the week is allotted to school, part to earning the living in some practical occupation. Unless we establish a compulsory part-time continuation system which will carry the pupils on to 18, the education of the earlier years of the youth of the nation will still be largely wasted. If the first step to retain those who leave school before the age of 18, under some educational control is secured, it will be easy to take them to the threshold of adult education, where the solution of the problem of educating the democracy must be found. The experience of Denmark is encouraging. The Danish Folk High School is attended by 30 per cent. of the small farmer and working-class population, voluntarily and at their own expense, for five months, and the education is humanistic in the sense that it is neither technical nor utilitarian. The main point is to urge the indispensability of adult education, to review what it has already done in order to harmonise, develop and complete it.

Agriculture.

President: PROF. J. HENDRICK.

SOIL SCIENCE IN THE TWENTIETH CENTURY.

THIS is perhaps the first time that a Presidential Address deals specifically with soil science as a fundamental subject, though some of its aspects have received attention in the past as from the nature of things such reference was unavoidable when dealing with the various different problems of crop production which have formed the subject of those addresses. It was only in the last century that the vast store of practical knowledge built up solely through experience and handed down by tradition began to be succeeded by a knowledge of the science, advance in chemistry and geology being chiefly responsible. In Great Britain the provision for agricultural research was for a long time meagre, Rothamstead, Cirencester and Edinborough being about the only centres of study and research. A forward move was possible only with the Development Commission of 1910, but the easier and more obvious problems of manuring and field experiments claimed first attention and soil studies were stagnant; such as were taken up were mainly from the point of view of its fertility and usefulness as a medium for crop production and not in any of its fundamental aspects. British views on soils remained rather narrow and insular, the soils of S. E. England being regarded as the types, notwithstanding the variety of location and climate even in this small island which have given rise to a corresponding variety of soil types. In contrast with Great Britain the countries of America and Russia embrace vast areas extending through wide ranges of latitude and climate, with great variations in geological conditions and with soils derived from many kinds of rock formations. Arid and alkaline soils were also a special group. Soil studies there were more comprehensive accordingly

but British thought could be influenced only by the studies of American workers, the barrier of language rendering Russian work inaccessible and therefore unknown in Britain for a long time. No better picture of the gradual growth of recognition in Great Britain of the Russian school and its work can be found than the bibliography appended to the different editions of Sir John Russels' book *Soil Conditions and Plant Growth* which devotes adequate attention to the work of this school only in its latest or sixth edition of the year 1932. It was through the agency of the International Society of Soil Science which was founded in Rome in 1924 that publicity was afforded to this new knowledge of soil science, although this itself grew out of international conferences on Agrogeology held before and after the Great War at Budapest, Stockholm, Prague and Rome, which last led to the formation of the International Society and later to an International Congress at Washington in the year 1927. It was at this congress which was attended by a large contingent of British, American and Russian workers that the new views of the Russian school were fully explained, demonstrated and discussed, making it to many a new education in soil science. Other agencies for publicity have not been wanting and the journals *Soil Research*, *Soil Science* and the *Proceedings of the International Society* are doing much to make known widely these new movements.

The historical background having thus been described, these new views of the Russian school of soil science may now be discussed. In the first place, the Russian school treats the soil as an independent natural body worthy of study for its own sake and not merely as a medium for plant growth or as subsidiary to chemistry, geology or other sciences, according it a new and separate status under the name of Pedology. Secondly, the Russians regard climate the most important among pedogenic factors and hold that its nature is not determined by its geological origin. They have shown that very different soils may be formed from the same rock in different climates and on the other hand similar soils may be produced from different rocks under similar climatic conditions; that, for example, the granitic soil produced in the cold humid climate of Scotland would have been different if produced in the hot humid climate of Africa and would be still more different if produced in a hot arid climate in Asia. The climatic zones indeed form the basis of classification, so much so that one can detect a tendency to go too far in excluding geological origin as an important factor. A third feature of the new science is the study of the "soil profile" and of the "horizons" which go to make it up. The virgin soil unchanged by human agency is what is required for this purpose, which is a condition impossible to satisfy with soils in many of the most important parts of the world and which would therefore necessitate some modification in the methods. The profiles are also sought to be classified as mature and immature; but the soil-forming processes greatly vary in their duration, some requiring periods of geological time while others can take place in a few centuries or even in a few years. The granitic soils of Scotland are examples of the former and factors which produce changes in the organic matter content of soils come under the latter category. Much further study is therefore needed before these can be properly accounted for and a satisfactory system of soil classification established.

The importance of soil moisture and rainfall as climatic factors in soil formation is recognised especially as they may be influenced by the humidity, temperature, topography and the amount and distribution of the rainfall itself. The closely relevant study of soil drainage and of the changes taking place in the composition of the soil and the soil water during the process has not received the attention that it deserves in this connection. This is owing probably to the difficulty of constructing drain gauges which will deal with soil in its natural *in situ* condition and not with soil moved and filled into the cisterns. The latter are only of limited use in their application to actual field conditions. Reference may however be made to those in Rothamstead and those constructed by the author at Craibstone near Aberdeen which are of the type dealing with the undisturbed soil.

A notable advance in soil science is our knowledge of soil colloids and base exchange, K. K. Gedroiz the Russian worker, van Bemmelen, Dr. Hissink and G. Wiegner are noted names in this field and it is from their work that we know now that base exchange is a colloid phenomenon and that both mineral and organic colloids possess this property and that it is not the former alone which was concerned in the process as was supposed at one time. This advance has also enabled us to estimate the degree and intensity of soil acidity and alkalinity as well as to understand the exact rôle of lime in its capacity as an exchangeable base. The structure of clay, the nature of its base exchange capacity and the differences found therein have received considerable elucidation by the X-ray method which has revealed the presence of a lattice structure and of several different minerals showing at least two different types of lattice structure. X-ray methods are also clearing up the nature of humus and are furnishing evidence of its possessing a complex molecular structure.

Soil science is making steady progress in these and along other lines of research and in the British Isles soil problems are now being studied from many angles in the various research stations, colleges and universities. The British attitude towards soil science however is still somewhat utilitarian, in that it declines to dissociate soil study from its practical application, with the complete detachment of the Russians; one is primarily interested in the soil on account of its plant-growing capacity. Increased production of the products of the soil is a blessing and not a curse and a strong plea may be put in for the harnessing of science for increasing production, despite the cry of overproduction. As long as there is want and underfeeding in this world there cannot be overproduction.

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